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Hydro-Electric Development at Rochester

RELIEVING PEAK LOAD ON STEAM PLANT; UNUSUAL SYSTEM OF GENERATOR PROTECTION

IN THE POPULAR mind, hydro-electric development means a huge plant to serve half a state. Less striking, but often far more practical, is the moderate-sized plant, which adds the energy of some water-fall, strategically located, to a system which must rely on other sources for most of its power. Such is the new 25,000-k-v.a. station of the Rochester (N.Y.) Railway and Light Co., located in the gorge of the Genesee, in that city.

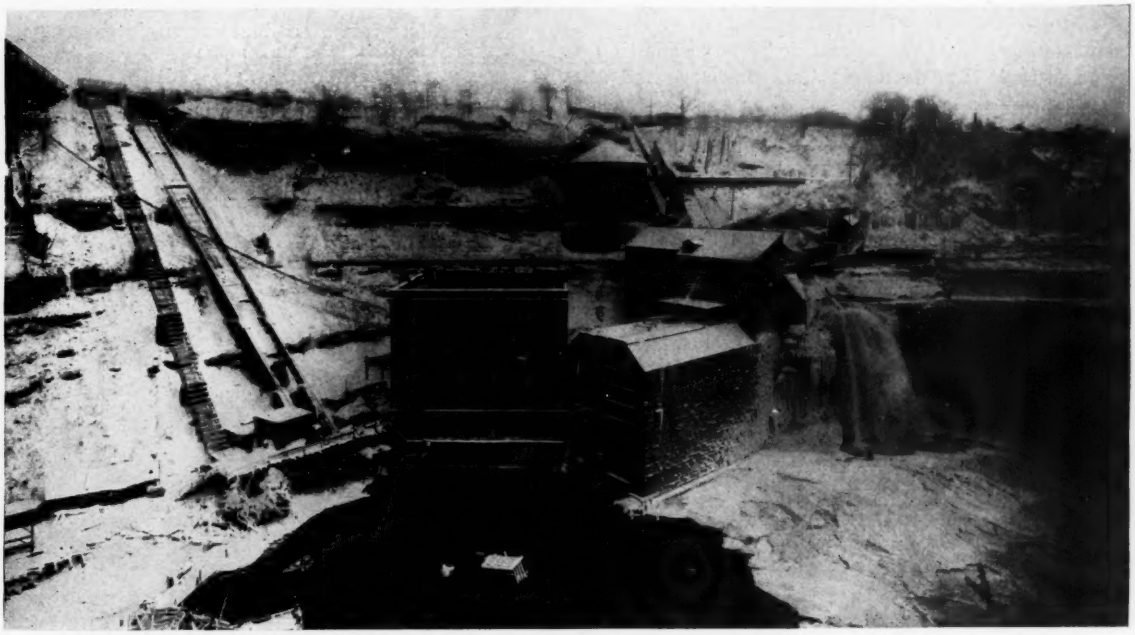


FIG. 1. EXTERIOR VIEW OF POWER STATION SITE SHOWING INCLINED RAILWAYS, NEW STATION, SURGE TANK AND OLD STATION

A study of the topography of the river showed that the proper place for a plant was near the bottom of a series of falls. Here was a reach of 1.5 mi. in which about 23,000,000 cu. ft. of water could be stored above two drops of 40 and 90 ft., respectively. The plant was designed to empty this pond daily during the dry season, taking the peak load off the steam station and shutting down overnight to allow the pond to fill. This would flatten the steam plant's load curve, giving improved efficiency.

The structures were designed for an ultimate capacity of 48,000 hp. and apparatus being installed to take 32,000 hp., a new dam was built composed of two 100-ft. sector gates which retreat into pits into the river bed, and four 50-ft. Taintor gates which can be raised clear of the water, giving an unobstructed passage for flood water of 83 per cent of the channel. The intake house is located at the center of the dam, and is provided with curtain walls extending 4 ft. below low-water level. This diverts much trash from the racks inside. Sixteen openings 12 ft. high and 10 ft. wide are provided with vertical gates to admit water to the tunnel. This is cylindrical, 20 ft. in diameter, and drops vertically, then turns into a section 1400 ft. long leading to the penstock connection at the power-house. Directly over this latter point is the vertical connection to the surge

tank located on a shelf of the high bluff back of the station. Each penstock connects through a Johnson valve to the scroll case of a turbine.

Two vertical Francis turbines made by the I. P. Morris Company are used. They are rated at 16,000 hp., 180 r.p.m., 130-ft. head and have runners of 96 in. diameter. The governors are of the double floating lever type, oil-operated. They are provided with remote control from the switchboard gallery, and may be controlled by hand also. A Kingsbury thrust bearing

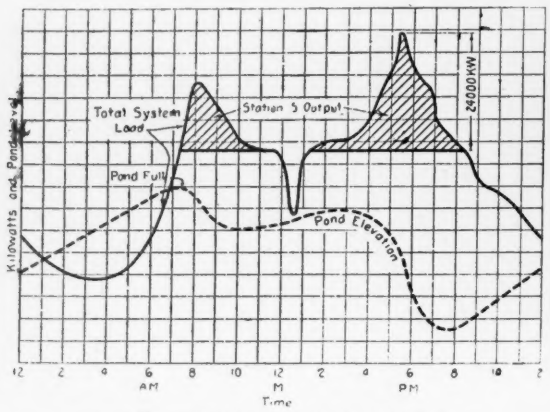


FIG. 2. TYPICAL DAILY LOAD CURVE

of 100 tons capacity is used to sustain the vertical (gravity plus reaction) load.

The two generators were furnished by the Westinghouse Electric & Manufacturing Co. Each is rated at 12,500 kv.a. at 0.90 power-factor, 3 phase, 60 cycle, 11,000 v., star-connected. Protection to the generators is given by the system of current transformers and relays proposed by Ricketts. In each phase a current-transformer is connected at the inner end and another one in the cable just inside the first disconnecting switch. The secondaries of these transformers are connected across a Westinghouse overload relay. Normal conditions cause a current to circulate through the two sec-

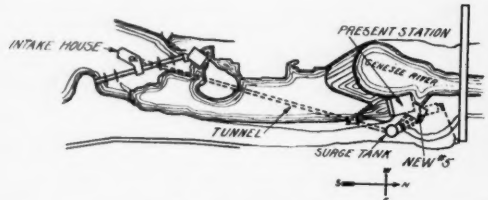


FIG. 3. LAYOUT OF SITE

ondaries, none following through the relay. Should a fault develop in the winding or cable, the leakage current would cause an unbalance in the transformer secondaries, which would force current through the relay. This would trip out the main oil circuit breakers and open the field circuit of the machine in trouble.

The upper guide-bearing bracket of each generator carries a 100-ton Kingsbury thrust bearing, which supports the rotating parts and water reaction. Above this is mounted a 100-kw. 250-v. exciter. Excitation can be secured also from a motor-generator set.

The station structure itself is of reinforced concrete in simple lines with large window areas. It covers a space 75 by 20 ft., which allows liberal space for the two present units only; before the third unit is installed the old building adjoining it must be removed and the station extended. The generator floor is 14 ft. above high water level. From this floor to the bottom of roof trusses is 59 ft. A central line of columns support the switch galleries which occupy one-half the station; the space over the machines is left clear for the crane.

FIG. 4. INTERIOR OF TUNNEL

From the generators, 11,000-v. cables pass to the high-tension bus structure on the topmost gallery. The framework of this is a combination of brick piers and pre-cast concrete slabs. The bus bars are arranged in a tier of compartments running down the center, with oil-switch compartments on one side and disconnecting switches on the other. Since this station also supplies a distribution network in its vicinity, two 5000-kv.a. 3-phase transformers are installed in compartments on

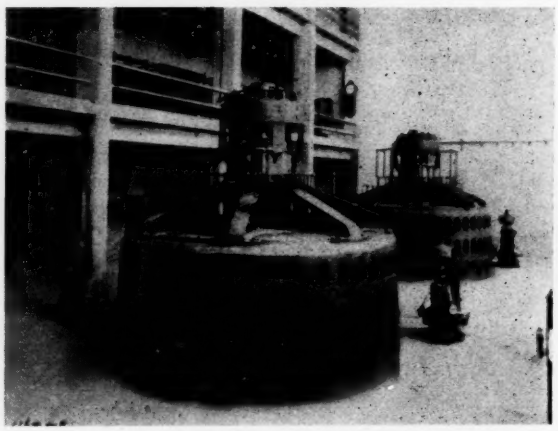


FIG. 5. OPERATING FLOOR, SHOWING TWO 12,500-KV.A. WESTINGHOUSE WATER-WHEEL GENERATORS

the main floor. These supply a 4150-v. bus on the first gallery level. Oil switches for the distribution circuits and for a number of arc transformers are located directly below this bus. The actual arrangement of switches, etc., is shown on the wiring diagram.

The main operating switchboard is located at the front of the first gallery. It was furnished by the

Westinghouse Electric and Manufacturing Co., and includes panels for the generators, spare exciter, tie lines, etc. Black-dial meters are used throughout. Potentiometers for measuring the generator temperatures are located on the face of each generator panel and connected to thermocouples imbedded in the machine windings.

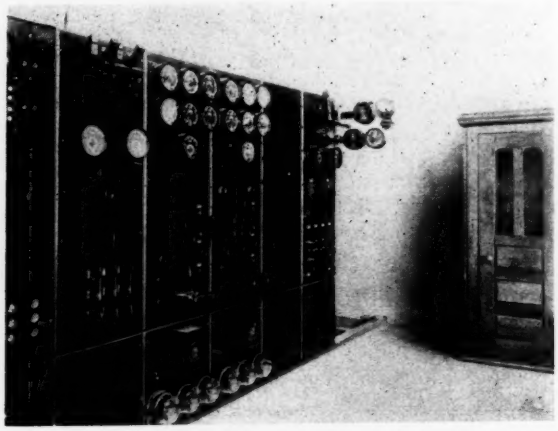


FIG. 6. GENERATOR END OF SWITCHBOARD, LEFT TO RIGHT, SPARE EXCITER; GENERATOR NO. 1; GENERATOR NO. 2; STORAGE BATTERY

Auxiliary power is furnished by 440-v., 3-phase motors. These include the spare exciter unit; a 4.5-kw. motor-generator set for the control-circuit storage battery; two 3-hp. motors driving oil pumps for the thrust bearings; two 15-hp. motors driving governor oil pumps and two compressors which furnish air for the governor accumulator tanks, for cleaning and for operating

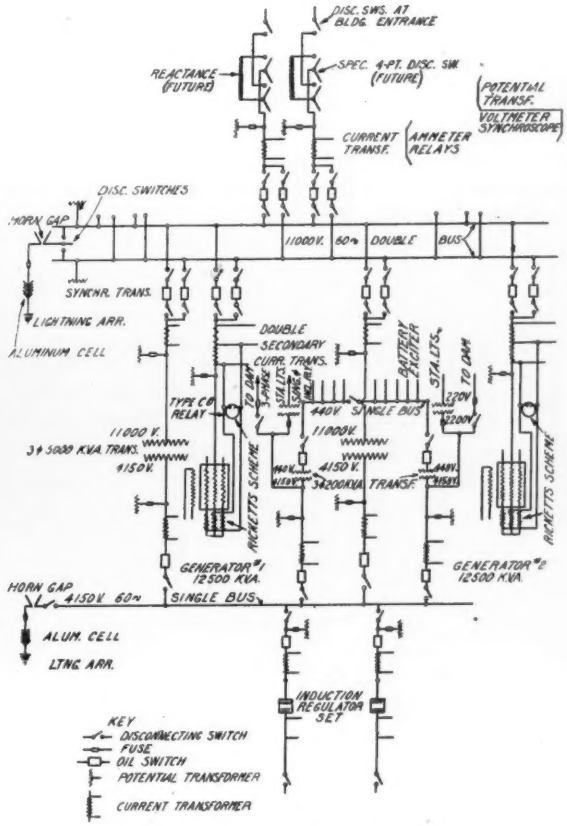


FIG. 7. ONE-LINE WIRING DIAGRAM

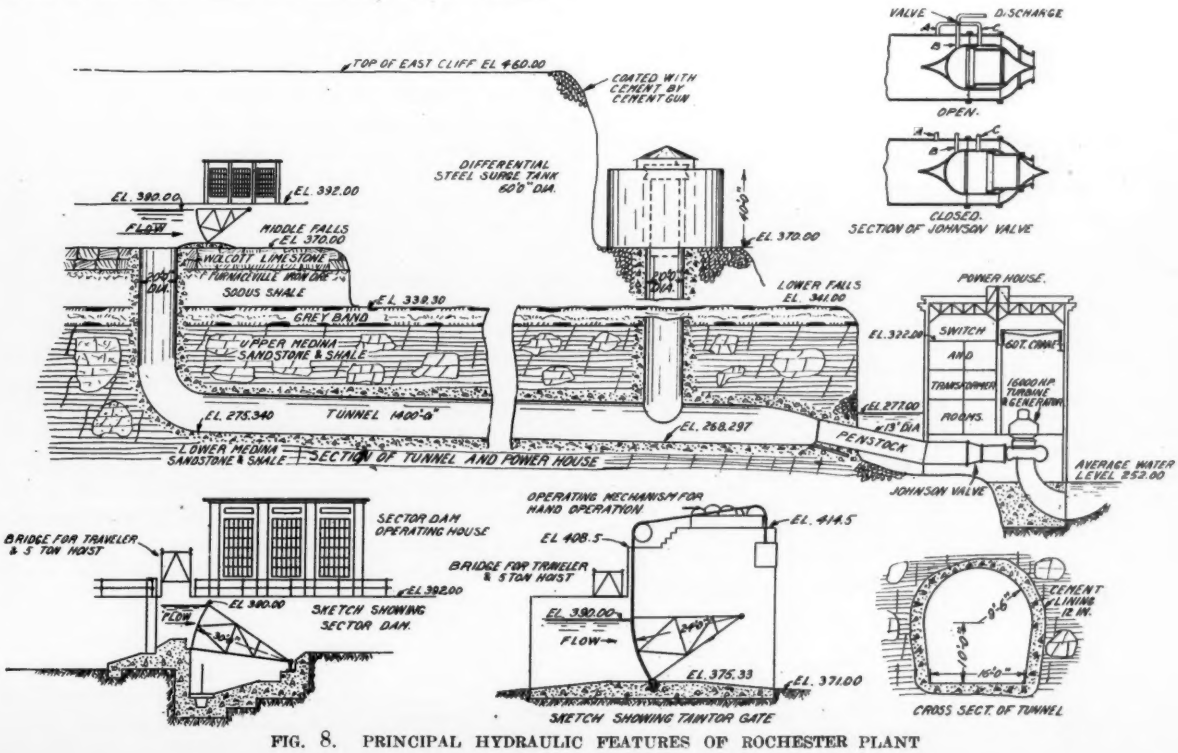


FIG. 8. PRINCIPAL HYDRAULIC FEATURES OF ROCHESTER PLANT

brakes on the generator fields for stopping. The crane motors are operated at 230 v. from the spare exciter. A double-throw switch connects this generator either as a shunt machine direct to the field-control panels at the alternators, or as a compound-wound machine through a circuit-breaker to the crane trolley.

Official approval for the project was given in March, 1916, and ground was broken on May 15. The work included the removal of an old building on the powerhouse site, removal of an existing dam and construction of a new inclined railway down the nearly vertical bluff near the power house, to lower a 40-ton load. The entire job cost approximately $1,750,000. It was designed and supervised by the Engineering Department of the Rochester Railway & Light Co., under the general supervision of F. J. Howes, chief. The detailed design responsibility was placed upon members of the Engineering Department: C. M. Whelan, hydraulics; W. S. Burch, electrical; E. R. Crofts, dam and miscellaneous; N. H. Guinter, field engineering. Outside advice was secured on special features of the work. The Dock Contractor Co. was general contractor for the job.

Prevention of Vibration in Power and Ventilating Plants

CAUSES OF VIBRATION AND FORMS OF FOUNDATIONS, HANGERS, SUPPORTS AND CONNECTIONS TO PREVENT COMMUNICATION TO BUILDING STRUCTURE. BY CHARLES L. HUBBARD

THE introduction of high-speed machinery into office buildings, schools, hotels, etc., for use in connection with elevator service, lighting and ventilation, has made it necessary to investigate means for eliminating, as far as possible, the noise and vibration which are usually associated with high velocities.

Even in manufacturing establishments constant noise is fatiguing, and this is generally recognized as a factor in causing accidents among the workers. Furthermore, constant vibration has a tendency to weaken the construction of a building. In the present case, we will confine our attention to the types of buildings first mentioned, where the trouble is caused by power and ventilating equipment only.

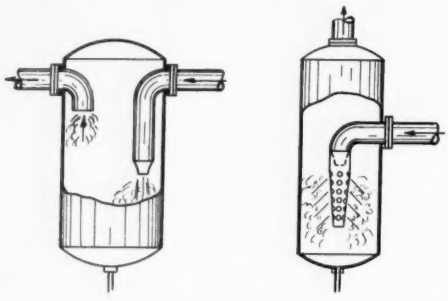


FIG. 1. SEPARATOR WITH CONTRACTED INLET
FIG. 2. SEPARATOR INLET NOZZLE WITH PERFORATED SIDES

Vibrations produced under these conditions may be classed under three heads, as follows: (1) Those due to the pulsation of steam, in connection with engines, and transmitted to the piping or building construction; (2) those caused by unbalanced or reciprocating parts of an engine, fan, or motor, and transmitted through foundations or other means of support; (3) and finally, those vibrations which are taken up by the air, such as the humming of a motor or the roaring of a fan.

VIBRATIONS DUE TO THE PULSATION OF STEAM

THESE MAY occur both in the supply and exhaust piping of an engine, being due in the first case to the periodic admission and cutting off of the steam, and in the last to the intermittent discharge into the heating system or to the atmosphere.

While the pulsations of steam in the supply pipe may be slight, their continued regularity may result in a vibration of considerable amplitude which may extend throughout the entire system of piping and even be transmitted to portions of the building itself. The common method of dealing with this has been to brace or anchor the pipe at one or more points in an effort to steady it. While this may be of some benefit where the vibration is slight, it is quite likely to make matters worse, rather than better, by interfering with expansion, and, furthermore, the vibration may be simply transmitted through the anchor to the building construction. It will be found true that the greater the number of abrupt turns in the piping the worse will be the effect of vibration, as it is at these points that the pulsations react most strongly. Also the velocity of steam flow has a direct bearing upon the matter, as the amount of vibration varies directly with the velocity within certain limits. While these latter conditions may be avoided to a considerable extent in laying out new work, they must usually be accepted and overcome after the piping is already in place. The most practical way of dealing with steam pulsations is to eliminate them, so far as possible, close to their source, rather than try to steady the pipe after it is set in motion. There are two ways of bringing this about which are often combined in the same piece of apparatus. One is to throttle the pipe near the engines, or at least beyond the bends, with a vena-contracta nozzle, to 25 or 30 per cent of its normal area, while the other is to introduce a receiver or separator of ample size, both of which tend to equalize the flow of steam and break up the pulsations. When throttled in this manner, the high velocity of the steam where it passes through the contracted nozzle tends to form a barrier which will prevent the pulsations of the engine from passing back into the piping beyond this point. As this necessarily creates a certain amount of resistance it is well to anchor the pipe near the contraction to offset this end thrust.

Separators, having a volume three or four times that of the high-pressure cylinder, placed close to the engines, will usually suffice where the piping is comparatively direct and well proportioned.

If the steam main is very long, with numerous changes of direction, it is well to place a large receiving chamber in the engine line where it leaves the main,

giving it a volume 10 or 15 times that of the combined high-pressure cylinders which are likely to be in use at one time.

Separators of a form where the steam is delivered downward at about the center of the receiving chamber, and taken off near the top, are especially effective for this particular purpose.

Arrangements employing a combination of contracted nozzle and receiver are shown in Figs. 1 and 2. In the first case the steam is discharged directly downward through the nozzle, while in the second the nozzle is connected with a tapering piece of pipe with a series of holes so placed as to discharge the steam against the sides of the receiver as shown. This tapered pipe is of cast iron and the holes are drilled at an angle so as to throw the jets partially downward. The area of the contracted nozzle in this case should be from 35 to 40 per cent of the normal pipe area.

The total area of the small holes in the tapered pipe should be about 50 per cent greater than the pipe area, so as to reduce the velocity somewhat as the steam enters the receiver.

Pulsations in the exhaust pipe may often be reduced by a slight change in the point of release, so that at full load the pressure in the cylinder will gradually drop to the atmospheric line at the end of the stroke, thus producing a more gradual discharge into the exhaust pipe. Such a condition may be brought about by making the release slightly earlier in the stroke.

It should be mentioned in this connection that a marked improvement may often be made by a change so small that it will interfere very little with the other events of the stroke.

When the exhaust is used for heating purposes it is always passed through an oil separator, and by making this of good size the same general results may be secured as already described in connection with the supply line.

As regards the pipe line itself, it should be of ample size to reduce the velocity as much as possible. Furthermore, if there are several engines connected with the same exhaust main, the branch from each should be brought in with an easy bend and joined with the main by means of a Y-fitting. This will greatly reduce reaction and resulting transverse vibration which is always set up when the branches are connected with the main at right angles. In any case there will be some reaction at these points and it is well to provide a reasonable amount of support to care for it.

In case of an outboard exhaust pipe, the pulsations may be reduced by making the horizontal main about 30 per cent larger than the total of the branches leading into it, and then reducing the vertical portion to the normal size. By this arrangement there will be a steady flow of steam to the atmosphere, while the beating or pulsations will be confined to the enlarged portion of the pipe, thus acting like a muffler on a gas engine.

Vibrations Due to Reciprocating and Unbalanced Parts

Under this heading are included vibrations which are transmitted from the foundations of engines, pumps, compressors, motors, fans, etc., and taken up by the building, steam piping, or air ducts.

While most builders of high-class engines so balance them that they will run practically without vibration when properly supported, the fact that they have heavy reciprocating parts makes it necessary to give especial attention to the foundation. This also applies in still greater degree to pumps, air and ammonia compressors, etc., which are less carefully cushioned. Turbines, dynamos and motors, having no reciprocating parts, are less likely to give trouble; but any high-speed machine of large size is bound to produce a certain amount of vibration, no matter how carefully it is constructed, which must be taken care of before it reaches surrounding objects.

The requirements of a foundation for any large piece of machinery are that it shall have sufficient weight, and a good footing which is entirely free from the building construction.

Even though this precaution is taken, the character of the soil has considerable effect upon the rapidity with which vibration is transmitted. Rock or wet soil, for example, will carry vibrations surprising distances, while dry gravel or sand acts as an efficient damper and absorbs them.

If the soil is of a composite character, the vibrations may extend considerably further in certain directions than in others. It is therefore evident from the above, that existing conditions must be carefully studied before the foundation is designed and laid down.

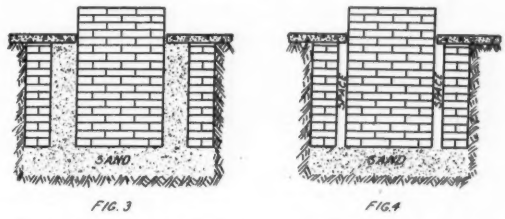


FIG. 3. FOUNDATION WITH SAND CUSHION ON ALL SIDES AND BOTTOM

FIG. 4. FOUNDATION RESTING ON SAND WITH OPEN SPACE ON SIDES

A typical foundation with an absorbing cushion of sand on all four sides and also beneath it is shown in Fig. 3. The weak point in this plan is that the sand will in time absorb moisture, and the continuous vibration to which it is subjected tends to pack it solidly about the central block of concrete, so that in time some of its absorbing power is lost. However, it is much better than filling in the space around the concrete with rocks and solid earth and will frequently produce the desired results.

Another plan, which overcomes some of the objections noted above, is shown in Fig. 4, in which the foundation rests upon a cushion of sand, but is separated from the surrounding earth on the sides by a narrow space formed by a concrete curbing. The floor of the engine room rests upon the curbing, but does not touch the central foundation.

Another arrangement, which will sometimes absorb a very slight vibration, is to place an elastic cushion beneath the engine bed and top of foundation, as in Fig. 5. This is especially adapted to engines of comparatively small size and to electric motors where the vibration is not excessive. The trouble experienced with

cushions of this kind, under heavy machines, is that the material loses its elasticity in time and so ceases to perform its work satisfactorily. Various materials have been used for this purpose, such as rubber, felt, and cork. Rubber is expensive and deteriorates rapidly, while felt takes a permanent set, and loses its effectiveness, even though combined with rubber and cork.

Cork is probably the best dampening material when correctly used. Various methods of applying it have been tried, but the best results have been obtained when the natural cork is cut in strips and bound together in a tight iron frame. Care must be taken to secure uniform bearing, for if an extra heavy load should rest upon some particular portion, the elastic limit of the material might be exceeded so that the vibrations would be easily transmitted.

Two simple methods of dampening motor vibration where it is slight are shown in Fig. 6. The first of these consists of a frame of some resilient wood, like spruce, placed upon the top of a masonry foundation. This may be made still more effective by placing several layers of cork beneath the wood, and also by adding the sand cushion shown in Fig. 3, in case of large and high-speed machines. For low-speed direct-connected motors, such as are used for driving ventilating fans, it is not usually necessary to provide the sand cushion unless the soil is very solid or rocky. A very good arrangement for a small motor is shown in Fig. 6B. This makes use of rubber washers at the corners, which, if used, must be renewed from time to time as the material becomes hardened. Short coil springs with suitable bearing plates at top and bottom are sometimes used in place of the rubber washers. Ventilating fans are usually mounted upon a foundation similar to that shown in Fig. 6A, and in case of much vibration being expected, the same precautions may be taken as already mentioned for motors.

There are many different ways of attaching small motors to the walls and ceiling of a building to give a

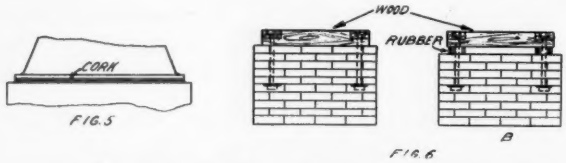


FIG. 5. CORK CUSHION BETWEEN ENGINE BED AND FOUNDATION

FIG. 6. SIMPLE METHODS OF DAMPENING MOTOR VIBRATION

minimum amount of vibration, but space does not allow of taking these up in any detail. Two of these are shown in Fig. 7.

A source of trouble in case of certain ventilating plants is the transmission of vibration from the ventilating fan to the galvanized iron ducts, where it is amplified so as to become very annoying, especially in the case of school buildings, libraries, churches, etc. This can usually be broken up by using a canvas connection between the mouth of the fan casing and the duct. This should be of heavy close-woven material to avoid air leakage and may be attached to the metal flanges by means of wooden or metal cleats and stove bolts.

Another detail of fan work, which may be included under this heading, although its office is to prevent undue friction of the fan and motor bearings rather than vibration, is the flexible coupling. In order to obtain the greatest possible quietness in fan action in large plants, it is now customary to use a slow-speed motor, direct-connected with the fan, in place of the high-speed belted type. When the motor is mounted directly on the framework of the fan, and both fan and motor have a common outboard bearing, an ordinary flange coupling may be used, as there is no danger of the shafts of the two machines getting out of alinement. It frequently happens, however, that the fan and motor are mounted on separate foundations so as to allow ample space for the air to enter both sides of the fan housing. In cases of this kind it is necessary to use a

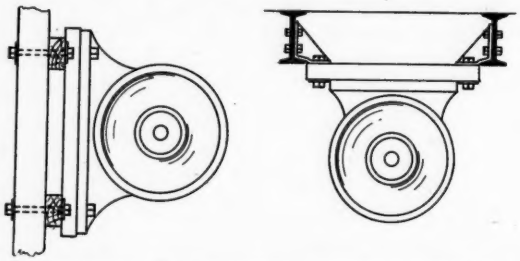


FIG. 7. METHODS OF MOUNTING MOTORS ON WALLS AND CEILINGS

shaft coupling which will have ample flexibility to offset any error of alinement in the two shafts which would cause friction in the bearings. Two forms of flexible couplings are shown in Fig. 8. The first of these will take up a small amount of inequality, and consists of a pair of flanges, attached to the ends of the shafts, with several sheets of rubber packing between. The nuts on the coupling bolts are drawn up so as to hold the rubber disks close together, but not so tight as to prevent sufficient flexibility to care for the imperfections in the shaft alinement without heating the bearings. The coupling shown in Fig. 8B has much more flexibility and is commonly used for large units where the fan and motor are placed some distance apart. In this case, the flanges are placed from 3 to 6 in. from one another, according to size, and each is provided with projecting iron pins as shown. Between these pins is woven a piece of heavy leather belting which prevents the pins on the two flanges from passing one another. This type of coupling has a considerable amount of flexibility and may easily be designed to give the required strength. Care should be taken not to have too much slack in the leather strip, neither should the motor be started up too suddenly, else the leather is likely to be torn.

While it is usually best to prevent the vibration of steam piping at the source, as already described, there are cases where the trouble may be slight, or perhaps confined to a single line or section. Under these conditions, the difficulty may frequently be overcome by the use of one or more spring hangers or supports. The principle of the former is illustrated in Fig. 9. Under ordinary conditions, the weight of the pipe is taken by the coil spring, but should this break, through continued use, the upper yoke to which the hanger is attached will be caught by the checknuts upon the side

rods so that the fall of the pipe may be limited to ⅛ in. or so. Sometimes it will be better to support the pipe from the floor, in which case the spring standard may be used, constructed on the general principle shown in Fig. 10.

Vibrations Taken up by the Air

This most frequently occurs in the humming of a high-speed electric motor or in the roaring noise produced by a ventilating fan of the centrifugal type. Air vibrations, under normal conditions, spread out uniformly from the center of disturbance, and gradually become dissipated without any marked change in direction. The elimination of air vibrations of this kind can, in most cases, only be brought about by completely enclosing the machine so that the sound waves cannot escape. As this trouble most frequently occurs in connection with the small high-speed motors, in the class of buildings under consideration, it is not a difficult matter to correct, as a wooden box or casing is easily constructed which may be placed over the motor and removed for purposes of inspection and oiling. A box of this kind should be thoroughly insulated against fire by lining with heavy asbestos paper or other fireproof material.

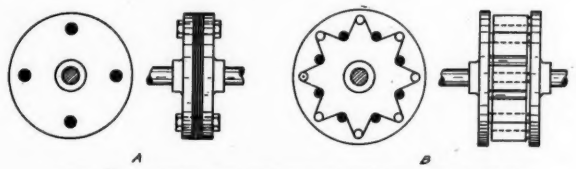


FIG. 8. FORMS OF FLEXIBLE SHAFT COUPLINGS

Openings must also be provided for ventilation in order to keep the temperature of the motor normal.

The roaring noise so commonly heard in the main distributing duct of a mechanical ventilating system is caused by the air impinging upon the comparatively thin lower edge of the blower outlet, as indicated by the arrow in Fig. 11, which represents a section through the outlet from a fan casing. Obviously, if this noise can be done away with by changing the form of outlet, it is much better than trying to smother it with a sleeve of canvas or other flexible material, which only prevents the vibration from being communicated to the ironwork without reducing to any extent the noise at the fan.

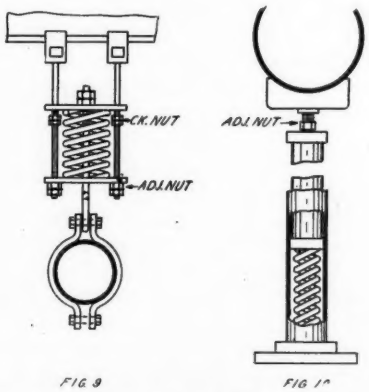


FIG. 9. SPRING HANGER FOR PIPES
FIG. 10. SPRING PIPE STAND

Figure 12 shows a fan casing with a V-shaped or "vanishing" outlet, which reduces this noise to a minimum without interfering in any way with the action of the fan.

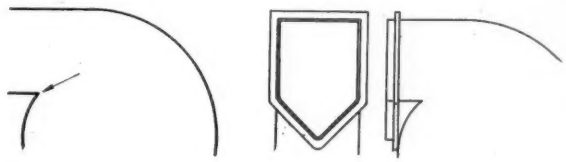


FIG. 11. FREQUENT CAUSE OF ROARING IN MECHANICAL VENTILATING SYSTEM
FIG. 12. V-SHAPED FAN OUTLET

Many fans, with outlets of this form, have been used in schools and churches, and the sheet iron distributing duct bolted directly to the casing, without objectionable noise or vibration of any kind.

A Yank's Plea

By G. Elanette Sollitt

Dear Folks back home:
Say, listen here!
We fellows hold our young lives dear,
We're over here to lick the Huns.
It's up to you to give us guns!
We'll do our best. But it takes cash
To furnish all us guys with hash;
Now get this straight and understand
All you must do is lend a hand.
So we suggest you buy a "bond."
We'll do the rest across the pond.
You're giving aid by lending gold.
And turning Fritzie's big feet cold!
Those bonds are good investments, too.
So buy a few! It's up to you!
Now au revoir! Help down the Hun
With greetings from
Your loving Son.

To handle the food for our boys in France five refrigerating plants are being erected, each to have a capacity of 3000 to 4000 t. of beef.

All materials, except lumber and concrete, are to be sent from this country, and a special regiment of men experienced in refrigeration work is being recruited to install and operate the plants.

Each plant will be 800 ft. by 300 ft. One plant now in operation has a capacity of 5000 t. of beef, which will be increased to 10,000 t. When completed, it will be 1700 ft. by 325 ft. and barracks will be built adjoining for the operating detachment.

There is also in operation an ice plant of 5000 t. daily capacity, which was taken over complete, including lumber from this side, and workmen went along to erect and operate it.

Meat is sent over in refrigerated ships, transported in refrigerator cars, and plans are now under consideration for refrigerator trucks to deliver the meat to the field kitchens at the front.

Improving Engine Economy---III

INFLUENCE OF FRICTION ON REDUCING CAPACITY AND ECONOMY; WHERE FRICTION OCCURS AND SUGGESTIONS FOR REDUCING IT. BY M. A. SALLER

AFTER the energy of the steam has been converted into work against the engine piston, it is important that this work be transmitted to the generator or engine shaft with the minimum loss due to friction. Experience has shown that the loss of work due to friction in the engine parts may vary from 4 to 8 per cent in a properly adjusted and lubricated engine up to 15 or 20 per cent where such care and attention is lacking. Since the loss in friction increases the cost of the effective power that is developed, but also cuts down the capacity as well, every endeavor should be made to reduce this loss to a minimum.

The loss due to friction may occur at a number of different points, i. e., at the main bearing, in the piston and piston rod, crankpin bearing, crosshead and wristpin, valves and valve rods, eccentric straps and in the valve links and eccentrics. Tests by Thurston on a

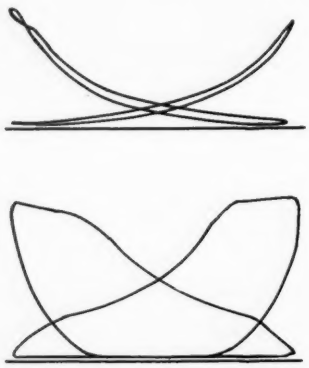


FIG. 1. SET OF TYPICAL FRICTION LOAD DIAGRAMS COMPARED WITH DIAGRAMS TAKEN WHILE ENGINE WAS LOADED

simple engine with a balanced steam valve showed the losses on account of friction were distributed as follows:

	Per cent
Main bearing	47.0
Piston and rod	33.0
Crankpin	6.8
Crosshead and pin	5.4
Valve and rod	2.5
Eccentric strap	5.3

In a similar engine, but using an unbalanced steam valve, it is of interest to note that the tests showed that the loss due to friction in the steam valve and rod rose from 2.5 to 26 per cent. In engines with intricate valve gears and reversing mechanisms, the loss in the eccentrics and valve links will also naturally increase in proportion.

Excessive friction is usually accompanied by heating or groaning of some kind, which of course sounds a warning to the operator; but frequently a considerable friction load can be carried without making itself apparent to the operator in any other way than increased power costs, or reduced capacity. A graphical statement of the actual friction load on an engine can be obtained by taking a friction load indicator diagram. The regular diagram of the engine working under a known load is taken. Then the load is removed, and a diagram taken while the engine is running free or "coasting" without load. All the power absorbed in the cylinder at this time to keep the engine in motion without producing power can be assumed as the friction load of the engine, though it should be borne in mind that this friction load represents that on the engine while running free. Under load, with all parts under greater pressure and stress, the actual friction load would doubtless be slightly greater.

As stated above, the matter of cutting down friction loss involves first of all proper design of the numerous parts, and then proper installation and adjustment, cleaning, and lubrication.

Taking up first the matter of the main bearings, probably the most common cause of undue friction loss in the main bearings of the engine is the too tight pulling up of the adjusting wedges or bolts. The bearing should be drawn up no tighter than is necessary to prevent knocking or motion. It is an unfortunate mistaken idea of many that the bearings can be drawn up until the point is reached where it does not heat. Once a bearing is properly set and kept oiled, it should not be necessary to take it up for months, hence, constant tinkering with the bearing is unnecessary and undesirable.

Where new bearings are installed, the friction loss at first will be greater than normal until the comparatively rough surface of the metal wears smooth and adjusts itself to the surface of the shaft. Therefore an engine with new bearings should be run at light load for a time, and should be supplied with plenty of oil to assist in the "breaking in."

The load should be distributed as much as possible over the entire area of the bearing in order to reduce the bearing pressure per square inch to the lowest point, and it is for this reason that quarter bearings permitting adjustment and alinement in four directions are preferable to the two-piece bearings. Warped or distorted bearing brasses or bearings that are not properly alined and fitted throw the load all on one portion of the bearing and cause heating and undue friction because of the high pressure concentrated on that point. An examination of the bearing will show the bright spots which should be scraped down into proper alinement, or new brasses should be supplied. Distortion of the bearings will also sometimes result from the engine bed or frame springing out of position.

Frequently excessive friction is caused by the contact of the edges of the brasses with the shafts. When the brasses start to warm up and heat, the edges naturally first begin to expand and as a result they may bear stiffly against the shaft, causing a binding action. This can be overcome by rounding off the edges of the brasses.

The interference with the lubrication or the cutting off and curtailment of the supply of oil also naturally tends to increase the friction loss. Empty oil cups or

oil cups that do not feed because they are clogged with thick oil and dirt are frequent occurrences. Oil holes in the bearings and oil cups should be cleaned out frequently to remove any accumulation of sediment. Oil should be fed to the bearings in a constant quantity, drop by drop. The proper quantity of oil applied constantly serves the purpose just as well as the wasteful flooding of large quantities of oil, unless an automatic system is used whereby the lubricant is used over and over again. Grit in the oil should be eliminated by the use of filtered oil only.

The friction loss increases with the pressure; hence, where the bearing is too small for the load the increased bearing pressure causes increased friction. Where a larger bearing cannot be substituted, special care should be taken in lubricating the bearing with good oil in sufficient quantities to maintain a film of oil between the bearing surfaces at all times. Where heavy bearing pressures are encountered a lubricating oil with a heavier body should be used than where lighter pressures are encountered.

As an aid in keeping a generous oil film in large bearings, it is advisable to cut oil grooves or channels in the bearing surfaces to act as oil storage and distributing ducts. The grooves also act as traps for retarding any

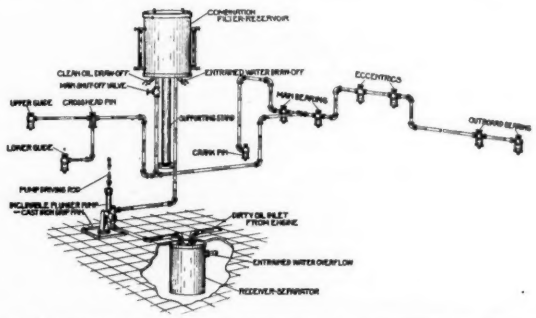


FIG. 2. DIAGRAMMATIC DRAWING OF INDIVIDUAL ENGINE OILING AND FILTERING SYSTEM

grit or dirt that may find its way into the bearing. The oil grooves should never extend to the outer edge of the bearing because they will allow the oil to escape.

The most efficient lubrication of the main bearings can be secured by a continuous flow of oil over the bearings, the oil being collected, filtered and used over and over again. Or many bearings are fitted with ring or chain oilers which pick up oil from reservoirs built in below the bearing and containing oil. In this type of bearing the reservoirs should be provided with clean-out connections so that the oil can be drained out from time to time and filtered to remove grit and dirt which may have accumulated. The same precaution should be taken in splash oiling systems.

The crankpin and bearing is usually lubricated by means of an independent sight feed oil cup connected directly over the bearing, or by means of a telescopic oiler feeding oil through a flexible connection. The friction loss in the crankpin does not represent a very considerable item though this bearing frequently gives trouble from knocking because the crankpin or bearing wears down on one side because of motion due to a poor fit. Where a loose crankpin is encountered, taper pins tapped in around the periphery of the pin usually serve to hold it tight in place. The grease cup is often advocated as a means of lubricating the crankpin, but this method is not generally desirable because the cup cannot be inspected or adjusted when the engine is running. Grease is also undesirable because of its tendency to run away if the bearing tends to heat up.

The crosshead is usually lubricated by a wiper by means of which a small quantity of oil is wiped off onto the crosshead oil pipe as it passes with each stroke of the engine. Special care should be taken in oiling the crosshead slide and bearing due to its proximity to the hot piston rod, rendering the parts subject to heating unless supplied with plenty of oil.

For eccentric practice, the grease cup represents a fairly satisfactory method of lubrication. Where grease cups are installed on eccentrics they should be in duplicate so that in case one cup clogs or empties in operation the other can be thrown in service without stopping the engine.

Next to the main bearings, the other principal source of friction loss is in the cylinder and piston rod and valves. The endeavor to prevent leakage of the steam past the piston by the use of spring rings on the piston naturally causes a friction loss varying as the pressure exerted by the rings. For this reason, considerable care should be exercised in cutting and fitting the piston rings so that they do not cause excessive friction. The weight of the piston traveling back and forth resting on the cylinder walls also dissipates power. Then another friction loss is encountered in trying to keep the piston rod fairly tight so that steam will not leak past.

The matter of the fit of the piston and rings in the cylinder is of extreme importance because it should be free enough to prevent excessive friction loss, and yet be tight enough to prevent leakage and allow for the necessary oil film for lubrication. The most common source of trouble lies in the distortion of the piston rings due to strains when being machined or put in position. The snap rings are usually made of a thickness equal to $\frac{1}{3}$ of the diameter of the cylinder plus $\frac{1}{8}$ in., and are made wide enough to fit easily in the grooves. They are usually turned to a diameter $\frac{1}{4}$ larger than the cylinder, and then enough metal is cut out of the ring to allow it to fit into the piston ring groove within the cylinder wall.

The piston rings are also often made sluggish and stiff because of the presence of grit or bits of packing which find lodgment in them. Then again breakage of the rings may jam pieces of the ring against the cylinder wall and cause scoring and friction. Where a tight contact cannot be secured without excessive spring tension, the trouble can sometimes be remedied by using a light ring and drilling a couple of 3/16-in. holes between the head and crank and flanges of the piston leading to the respective ring grooves so that the steam pressure will be communicated to the ring and tend to hold it tightly against the walls.

In order to provide an oil film on which the piston rings may ride with the least friction, lubrication with a good oil is necessary. Because of the high pressure encountered in the engine cylinder an oil that will not decompose at the temperature of the steam is an essential requirement. The best method of introducing the oil is with the incoming steam into which it is forced by

an oil pump or hydrostatic lubricator, and the oil will then be distributed with the steam to all parts of the valves and cylinder. The presence of water in the steam will naturally tend to wash away a portion of this oil, hence it is of advantage to supply dry steam to the engine. One engine requiring five pints of oil daily when using wet steam cut this down to two pints when dry steam was supplied. The rate at which the oil should be fed represents quite a problem because of the varying quality of the steam and the friction and the steam temperature. Some tests on a 150-hp. compound engine, operating under 150-lb. pressure, to determine the effect of the varying quantity of the oil fed, showed the following results:

Ounces of oil used per Hour	Steam consumption per Kw.-Hr.
2.2	29.7 lb.
1.0	30.9
0.5	33.1
None	36.1

This indicates an increased consumption of steam of 20 per cent when the oil was cut off, due to increased leakage and friction.

In connection with the piston rod stuffing box, myriads of methods and schemes for preventing steam leakage, and at the same time friction loss, have been proposed, involving the use of ring packings, labyrinth glands, metallic packing rings, extra deep stuffing boxes, etc. Under ordinary conditions, however, the ordinary type of stuffing box with good live packing should prove satisfactory, providing the packing is kept in good live condition, and is not drawn up too tightly. The tendency of engineers to stop leaks by pulling up the packing gland when instead new packing should be inserted, represents a frequent source of loss. Subjection to the intensive wear and heat of the piston rod will naturally glaze and harden a packing so that it is but reasonable that it should be renewed from time to time. Packing usually swells when warmed, hence if the packing is cut the full size of the box and is put in position, the chances are that it will expand and bind and cause excessive friction when the steam is turned on. At least ¼ or ½ in. should be allowed for expansion when cutting packing for stuffing boxes. Before being put into place the packing should be dipped into cylinder oil. Lubrication in packing is essential to maintain the packing in soft, pliable condition and to reduce friction on the rod. If friction is produced, the rod heats and the packing swells and causes still further binding. A simple method for securing the lubrication of the rod packing is to place an oil cup so that the oil will drop on the piston rod, or by keeping a swab of waste in touch with the rod and allowing the oil to drop into it. Lubrication of the packing usually increases its effective life 3 or 4 times. Sometimes the wear on the rod through the box will produce a shoulder on the rod when it is almost impossible to stop leakage, and a new rod is the only satisfactory remedy.

When a rod is pitted, leakage is also bound to occur, as well as increased friction. If the pitting is not too pronounced, the work of the stuffing box can be assisted by swabbing the rod several times daily with a mixture of tallow and white lead in equal parts. The tallow melts and acts as a carrier for the white lead, which works into the grooves or pits where it lodges and gradually fills them up.

While often very considerable savings in power can be effected by readjustment and proper alinement of bearings, probably the greatest and most apparent money savings can be secured by giving attention to the method of applying the lubricating oil to the bearings, etc.

The individual oil cup system allowing the oil to flow to the bearing drop by drop insures fairly good lubrication if the operators do not overlook filling the cups and the feed is properly regulated; but with this system the oil, once it flows from the cup over the bearing, is lost because it is allowed to drain to waste. In some cases, the rate of feed is increased and pans are installed to collect the oil overflow, following which it is re-filtered and used over again. This latter method has an advantage over the former in that better lubrication is secured and the oil waste is cut down, though it does represent a constant fire hazard, and involves constant attention in refilling the oil cups, filtering, etc.

The most satisfactory and economical method is to install one of the commercial automatic lubricating systems for supplying a stream of cooled oil continuously to the bearings, comprising a system of pipes for distributing the oil, for collecting the surplus, and a filter for removing the first and abraded metal, and a pump or overhead tank for redistributing the oil again to the points desired.

According to the size of the engine units, these equipments can be furnished from $50 up and they pay splendid returns because the oil is used over and over again without waste, and further, all personal oversight and attention required by the individual oil cup system is eliminated. The automatic system will often cut down the oil bill from 50 to 90 per cent and will insure better and more positive lubrication since it is possible to use oil in greater quantities because it is collected after passing the bearing and used over and over again. Tests published covering a bearing 4 in. long showed that the frictional resistance when the bearing was lubricated with an oily pad was 7.9 lb., when lubricated with a saturated oil pad 4.4 lb., and when supplied with a full stream of oil but 2.8 lb., representing a reduction in friction loss of 44 to 65 per cent respectively. It can usually be figured that the installation of an automatic system will easily pay for itself completely in a year's time.

WHY ARE the people of the United States asked to limit themselves to 2 lb. sugar per person per month for household use?

In order that the people of England may have 2 lb. per person per month.

The people of France 1½ lb. per person per month.

The people of Italy 1 lb. per person per month.

Those amounts are not guaranteed by the allied Governments, but are the maximum amounts that will be furnished if supplies can be obtained.

The British are not complaining.

The French are not grumbling.

The Italians grin and go without.

HE ALSO SERVES who stays and saves.

Fuel Economy in Hand-Fired Power Plants*

Preparation of Coal and Its Storage

COAL occurs in the earth in beds or seams, and usually in a solid mass as a rock. In mining it is blasted with powder, shoveled into cars, and conveyed to the surface. In the process of mining and handling it becomes broken up into pieces of all sizes. It may have some rock or dirt from the floor and roof of the mine mixed with it or there may be bands or layers of earthy matter in the coal seam itself. Coal as it comes from the mine is therefore not usually in condition for immediate delivery to the consumer, but ordinarily must first be "prepared" in order to remove these impurities and to separate it into the proper sizes for various purposes or markets. The impurities in the large sizes of coal are removed by picking them out by hand, and in the smaller sizes by treating the coal in cleaning machinery. Separation into different sizes is accomplished by sending the coal over screens having holes of the proper size.

For large power plants the custom of purchasing coal on the B.t.u. basis is increasing and if the specifications for such purchase are properly drawn and understood it is the logical way to buy coal, because it is equivalent to buying so many heat units instead of so many tons of coal. Upon this basis a purchaser should be able to determine whether a low priced coal which gives less efficient boiler service and involves greater expense for handling ashes is really cheaper than a higher priced coal.

With reference to the selection of different Illinois coals, the B.t.u. value and the percentage of ash furnish a general guide to their relative values. If two coals are otherwise alike in composition, the ash content increases as the B.t.u. value decreases; hence their relative values may be expressed with fair accuracy by either the B.t.u. or the ash value alone, although the evaporative value of any coal drops off more rapidly than its B.t.u. value when the ash content exceeds 10 or 15 per cent. A close approximation of the percentage of actual heat producing material in Illinois coal may be obtained by dividing the B.t.u. value of the coal by 155. Thus, a 12,000-B.t.u. coal contains 12,000 divided by 155, or 77 per cent of heat-producing material. In order to enable the small consumer to judge the relative values of coals offered at different prices, the chart herewith has been prepared to show the theoretical value of coals of different heating or B.t.u. values at various prices per ton.

It should be understood that the purchase of coal on the B.t.u. basis does not insure a maximum evaporative value from the fuel, because a high-grade coal carelessly fired may give poorer results than a low-grade coal carefully fired. In other words, the B.t.u. value of a coal is simply an indication of what should be obtained with careful firing and the person who furnishes coal of a high B.t.u. value cannot be held responsible for poor results obtained from that coal through improper use. It should also be remembered that while the B.t.u. value shows the chemical composition, it indicates nothing with regard to the physical properties of the coal, and these properties may be equally as important as the chemical properties in their effects upon firing, storing, and transportation.

*Abstract of Circular No. 7, entitled Fuel Economy in the Operation of Hand-Fired Power Plants, published by the University of Illinois Engineering Experiment Station.

Storage of Coal

THE STORAGE of a certain amount of coal by every power plant is both desirable and essential in order to insure continuous operation. Although there is some misapprehension with regard to the practicability of storing bituminous coal, a study of the subject based upon the reported experience of more than a hundred firms and individuals indicates that the difficulties attending storage are not serious. These investigations have shown that:

1. It is practicable and advantageous to store coal, not only during war times, but also under normal conditions near the point of consumption. The practice of storing coal has the advantage of (a) insuring the consumer a supply of coal at all times, (b) permitting the railroads to utilize their cars and equipment to the best advantage, and (c) permitting the mines to operate at a more nearly uniform rate of production throughout the year. The expense of storage may be regarded as the expense of insurance against shut-downs.

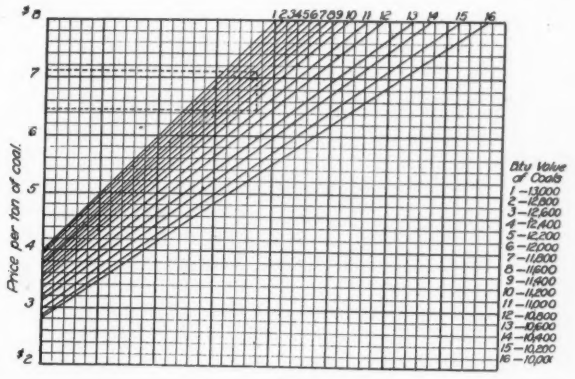


CHART SHOWING THEORETICAL VALUE OF COALS OF DIFFERENT HEATING VALUES AT VARIOUS PRICES PER TON

2. Certain requirements affecting the kinds and sizes of coal must be observed as follows:

(a) Most varieties of bituminous coal can be stored successfully if of proper size and if free of fine coal and dust. The coal must be so handled that dust and fine coal are not produced in excessive amounts, and allowed to remain during storage. Although some coals can be stored with greater safety than others, the danger from spontaneous combustion is due more to improper piling of the coal than to the kind of coal stored. The danger of spontaneous combustion can be very greatly reduced if not entirely eliminated by storing only lump coal from which the dust and fine coal have been removed.

(b) Fine coal or slack has sometimes been stored successfully in cases in which air has been excluded from the interior of the pile. Exclusion of air from the

interior of a pile may be accomplished (a) by a closely sealed wall built around the pile, or (b) by very close packing of the fine coal. A pile of slack must be carefully watched to detect evidences of heating and means should be provided for moving the coal promptly if heat develops. The only absolutely safe way to store slack or fine coal is under water.

(c) Many varieties of mine run bituminous coal cannot be stored safely because of the presence of fine coal and dust.

(d) Coal exposed to the air for some time may become "seasoned" and thus may be less liable to spontaneous combustion because of the oxidation of the surfaces of the lumps. Experience covering this point, however, is by no means conclusive.

(e) It is believed by many that damp coal or coal stored on a damp base is peculiarly liable to spontaneous combustion, but the evidence on this point also is not conclusive. It is safest not to dampen coal when or after it is placed in storage.

3. The sulphur contained in coal in the form of pyrites is not the chief source of spontaneous combustion, as was formerly supposed, but the oxidation of the sulphur in the coal may assist in breaking up the lumps and thus may increase the amount of fine coal, which is particularly liable to rapid oxidation. The opinion is widespread that, if possible, it is well for storage purposes to choose a coal with a low sulphur content.

4. In piling coal for storage the following conditions should be observed:

(a) To prevent spontaneous combustion, coal should be so piled that air may circulate through it freely and thus may carry off the heat due to oxidation of the carbon, or it should be so closely packed that air cannot enter the pile and stimulate the oxidation of the fine coal.

(b) Stratification, or segregation of fine and lump coal, should be avoided, since an open stratum of coarse lumps of coal may provide a passage or flue for air to enter and come in contact with the fine coal, and thus to oxidize it and start combustion.

(c) Coal can be stored with greater safety in piles not more than six feet high than in piles of greater height since the coal is more fully exposed to the air in low piles, the superficial area of the pile in relation to its volume being greater. The coal pile should preferably be divided by alleyways so as to facilitate the rapid removal of the coal in case of necessity and so that an entire pile may not be endangered by a local fire.

(d) The practice of ventilating coal piles by means of pipes inserted at intervals has not proved generally effective as a means of preventing spontaneous combustion in storage piles in the United States and it is not advised. Such practice is, however, reported to have been successful in certain parts of Canada.

(e) Coals of different varieties should not be mixed in storage, because a single variety of coal which has a tendency toward spontaneous combustion may jeopardize the safety of the entire pile.

(f) Storage appliances and arrangements should be designed so as to make it possible to load out the coal quickly if necessary. Coal should positively not be stored in large piles unless provision is made for loading it out quickly.

(g) Pieces of wood, greasy waste, or other easily combustible material mixed in a coal pile may form the starting point of a fire, and every precaution should be taken to keep such material from the coal as it is being placed in storage.

(h) It is very important that coal in storage should not be affected by external sources of heat such as steam pipes. The susceptibility of coal to spontaneous combustion increases rapidly as the temperature rises.

5. The effects of storage on the value and properties of coal may be summarized as follows:

(a) The heating value of coal as expressed in B.t.u. is decreased very little by storage, but the opinion prevails that storage coal burns less freely than fresh coal. Experiments indicate that much of this apparent deficiency may be overcome by keeping a thin bed on the grate and by carefully regulating the draft to suit the fuel.

(b) The deterioration of coal when stored under water is negligible, and such coal absorbs very little extra moisture. If only part of a coal pile is submerged, the part exposed to the air is still liable to spontaneous combustion.

6. In order to guard against loss in the event of fire in a pile of stored coal the following facts should be understood:

(a) The best means of preventing loss in stored coal is to inspect the pile regularly and if the temperature in any part of the pile rises to 150 deg. F. to prepare to remove the coal from the spot affected. If the temperature continues to rise and reaches 175 deg. F., the coal should be removed as promptly as possible. Temperature readings may be taken by lowering a thermometer into the interior of a pile through a pipe driven into it. The common methods of testing for fires in coal piles are: (1) By watching for evidences of steaming. (2) by noting the odor given off. (3) By inserting an iron rod into the pile and when drawn out noting the temperature by applying the hand. (4) By inserting maximum temperature thermometers into pipes driven into the pile. (5) By noting spots of melted snow on the pile.

(b) Water is an effective agent in quenching fires in a coal pile only if it can be applied in sufficient quantities to extinguish the fire and to cool the mass, but unless there is an ample supply for this purpose it is dangerous to add any water to a coal pile.

IN ORDER to assure the more complete coordination of the various Ordnance departmental activities along metallurgical lines, it has been decided to establish a Board on Metallurgical Matters. The appointment of this Board will also assure the complete coordination of similar activities of the different divisions of the War Department and the War Industries Board.

The Board will act not only for the various sections of the Ordnance Department but also in connection with the manufacturers working for and with the Department in the production of war material, and will gather the most recent and complete information on all metallurgical products.

MAKE EVERY DAY a thrift day and help your Government end the war days.

Fighting Power House Fires

METHODS EMPLOYED TO RESUME SERVICE IN MINIMUM TIME. BY C. B. HUDSON

OBSTACLES overcome in maintaining service at a central station following a fire which crippled the plant will undoubtedly be of interest to readers of Power Plant Engineering.

The plant in question furnished light and power for a moderate sized city and was run in connection with a manufacturing plant which utilized not only all of the exhaust steam from the power house, but also about 40 per cent of the live steam.

The pumps supplying the boiler plant with make-up water were located in the manufacturing plant, which was about 200 ft. distant and a matter of 30 ft. lower in elevation on the shore of a large lake.

The chief had just arrived home after a hard Sunday supervising repairs when the telephone rang and he was informed of a bad fire in the manufacturing plant. After hurried instructions as to what the operator should do, the chief made all possible speed to the nearest garage for a taxi, as the plant was located nearly a mile outside the city.

Upon arrival at the plant it was found that the make-up water pumps were already out of service and a large wooden bridge connecting the two plants was in flames and was seriously endangering the power plant, so all endeavors were turned toward saving it. This was accomplished after a stubborn fight with limited means, for although there was a large body of water near at hand it was impossible for fire apparatus to get to it.

Of course, the plant had to be shut down in the early stages of the fire and the fires under each of the seven large boilers were drawn, thus allowing the boilers to remain full of water.

As soon as the fire had subsided somewhat, the problem arose as to how we were to resume service without the make-up pumps, which were a total loss.

Our equipment consisted of three pairs of reciprocating engines running noncondensing and a bleeder type turbine which normally ran single-stage noncondensing, but was equipped for two-stage condensing operation, the condenser being of the surface type, served by a 10-in. centrifugal pump, driven by a 20-hp. induction motor, located in a brick pump house on the lake shore, and consequently was undamaged.

Our method of raising the water and priming the centrifugal pump was by means of a 2½-in. connection and valve from the water space into the steam space of the condenser. Hence, in priming our circulating pump the turbine was cut off from the condenser, the air pump started and the 2½-in. valve opened, which subjected the line from pump to condenser to a vacuum, the water being forced up into the pump by atmospheric pressure and advantage was taken of this 2½-in. connection to secure water for our boilers in the following manner.

The circulating water discharge from the condenser was disconnected and blanked by means of a hurriedly made wooden flange and a rubber packing. In the meantime, fires had been started again in the boilers and enough water remained to start an engine driven unit and as soon as it was on the line the circulating pump was started, and, presto! the steam space in our condenser and the hot well were full of water through the 2½-in. bypass. It now only remained for us to start the hot well pump, fill the feed-water heater and start the boiler feed pump and service was again restored after a shut-down of but 2 hr. duration. This arrangement must of necessity be temporary, however, as we desired to run the turbine condensing; so at 6 a. m., when the ruins had cooled sufficiently, we secured the services of a steam fire engine, placed it at the lake shore and ran a line of hose under a railroad track and across a highway to our make-up water tank and were soon supplied with abundant feed water. This arrangement was kept in service for 24 hr., during which time we ran a 2-in. steam line and a 3-in. water line for over 200 ft.; also a 5-in. suction line, and installed an old 6 by 5 by 5-in. duplex plunger pump at the lake and built a temporary wooden shelter over it; for several weeks this was our only source of supply. Many and varied were the experiences we had with this temporary installation and it was a continual fight against breakdowns, freeze-ups, etc., until a permanent pump of ample capacity was installed in the brick pump house and duplicate steam and water lines connected to it.

Later on, a second pump for use in emergency was installed, thus insuring against a recurrence of shutdown.

One incident which occurred while the fire engine was in service will serve to illustrate how close one can come to service interruption and avoid it if resourcefulness and the right remedy are applied.

The incident occurred about 4 a. m., just when everybody was dead tired from two days and nights of constant work against odds, and resulted from a broken hose which necessitated that the pumping engine be shut down while it was repaired, as our make-up supply would last only 20 min. The need for speed can be realized. Imagine, then, our feelings when it was discovered on trying to start up that the pump had become frozen. A hurried trip to the engine room for rags and kerosene followed. These were wrapped around the pump cylinder and valve chest, saturated with kerosene and a match applied.

The remedy was effective and the situation was saved.

The difficulties portrayed and the methods used to overcome them only go to prove that the modern power plant engineer must be a man of resourcefulness and courage and of such judgment as to be able to discriminate between a chance which permits of too much danger and the chance which, though not strictly called good engineering, is many times taken for the good of the service.

Did You Do Your Best?

TAKE NO COMFORT in saying "It is not my fault! I did my best." The question keeps bobbing up "Did you do your Best"? Every American killed facing the enemy is a charge on your soul unless you actually have done your best to back up the fighters by buying Liberty Bonds to the limit.

You have a chance to redeem yourself. The Fourth Liberty Loan is offered to you. Buy all you can pay for.

Preventing Spontaneous Combustion in Coal Piles

SIMPLE METHOD OF MAKING VENTILATING HOLES IN COAL PILE; HUNTING HOT SPOTS. BY S. E. BALCOME

THE GOVERNMENT, in the interest of coal conservation and for the help of those concerns which store coal in open dumps, has carried on investigations, and sent out pamphlets treating on coal storage and spontaneous combustion of coal.

In reading these pamphlets and also articles in the mechanical papers from various authors, together with some practical experience in dealing with heating and combustion in coal piles, the writer has summed up the following facts:

1. Bituminous run of mine coal, which is generally composed of fine coal, is almost sure to heat in some parts of the pile, sometimes at the bottom of the pile and often at the middle and even near the top of the pile.

2. Heating does not necessarily mean that it is going to take fire, but it may take fire in time if not watched and taken care of.

3. Heating is caused by oxidation of surfaces of the particles of the coal, and if the heat so caused cannot escape from the coal, the temperature will continue to rise until the coal has attained a dangerous rise in temperature, which also accelerates oxidation.

4. To prevent heating, either exclude air and oxygen from the pile as much as possible, or go the other way and ventilate the coal pile enough to carry away the heat.

The Government discourages the idea of ventilating the coal pile, saying that it is impossible to ventilate it enough to carry away the heat, but the attempt to ventilate will only furnish oxygen and aggravate the trouble.

Of course, there are some chemical compounds in the coal which are not stable and which are ready to absorb oxygen and form heat; however, this is a slow process and the amount of heat developed is small.

The writer is trying an experiment to prevent the coal from heating in a coal pile where it is piled from 14 to 18 ft. high, and it seems to be working very satisfactorily. The method consists of ventilating the pile, and it has kept the coal pile in question cool for 3 mo., the coal showing no dangerous degree of heat anywhere in the pile and actually cooling the coal off 10 to 30 deg. in one week's time in the pile, which is 18 ft. high. To do this, a 1-in. pipe is fitted with a long tapered sharp steel point at one end, and then the pipe, which is about 2 ft. longer than the coal is high, is pushed down to the bottom of the pile and carefully pulled out, after wiggling sidewise a little, so that when the pipe is drawn out the hole is left intact. These holes are made about 2 ft. apart each way wherever the coal is heating. By this means, there is no part of the coal pile which has not a ventilating space less than about 17 in. from it. These holes are easily made by 2 men, and do not fill up very badly, being necessary to go over them about once per week to open them up again. This is a great deal easier than to move the coal over.

To find the temperature of the coal pile the writer pushes a ½-in. steel pointed rod down through the pile, and after leaving it there for about ½ hr., pulls it up and feels of the rod the whole distance. This will give the exact location of the hot places, whether in the middle or bottom of the pile. Five or more rods should be used so that the man who does this should not have to wait for the rod to reach the temperature of the coal.

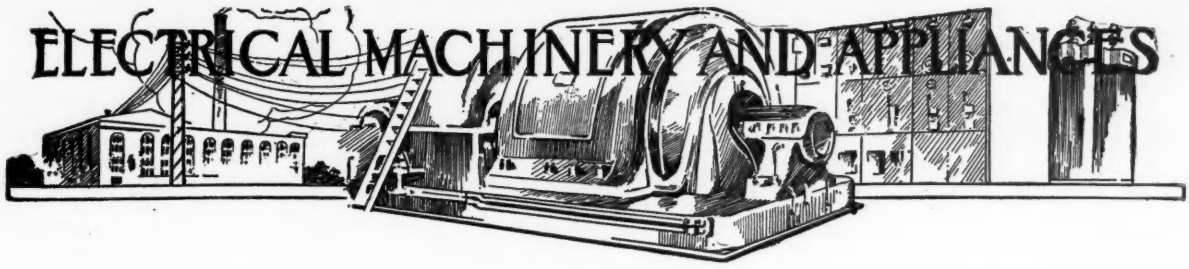
If it were possible to keep air from circulating through the pile positively, there could not be any heating after the oxygen stored with the coal was used up; but in the opinion of the writer, there is a slow circulation of air all the time through the coal, and unless the pile is covered over with some dense substance like sods, heating and firing are very liable to occur in coal dumped in an open field, unless ventilated sufficiently to carry off the heat.

The writer is indebted to a Mr. Nagle, who has charge of a large coal storage yard for the Boston & Albany R. R. at Worcester, Mass., for the idea. He has used this method for several years.

THE GOVERNMENT has found it necessary to arrange war emergency courses in Employment Management, in nine universities to date. These courses are designed to train men or women, who already have a basic experience of at least 3 yr. in industrial life and factory methods, and who have come in actual contact with shop problems. Employers of labor, particularly those having war contracts, are urged to suggest men or women from their own organizations as candidates for these courses. With the increasing tightening of the labor situation, it is essential that each man should be hired to do the thing he is best fitted to do, and it has been proved that an experienced employment manager comes near to solving the labor problem.

The courses of instruction in the various schools run from six weeks to two months; the course of study deals chiefly with the problems of employment management, but brief consideration is given to statistics, labor economics, and business organization and management. The subject of employment management covers the organization and equipment of an employment department, the employing, the training and the payment of the workers, the control or working conditions, and the government of the shop. There are no charges for the course, except the outlay for living expenses of students and about $15 for books and supplies. It has been arranged to begin new classes as soon as each previous class is graduated so application for admission to the courses in any of the schools may be made at any time. Employers of labor having candidates for admission to the classes and individual applicants, will be furnished with necessary information concerning qualifications for admission and other data regarding the courses by addressing Captain Boyd Fisher, 717 Thirteenth St., N. W., Washington, D. C.

JOSEPH WEINSTEIN, consulting engineer on structural and sanitary work, has moved his office from 502 Concord Ave., New York, to 2255 Broadway.



Static Condensers

THEIR USE AND ADVANTAGES. BY W. B. TAYLOR

IN THE generation, supply, and use of alternating current, one feature or property often overlooked by those familiar with direct-current work, is the power-factor of the apparatus converting the electrical energy into mechanical work.

For alternating currents, instead of merely multiplying the volts by the amperes to get the energy consumed, as in a direct-current circuit, this product must be multiplied by a further constant indicative of the reactive character of the circuit. This constant is called the power-factor.

If, therefore, there is no reactance in the load circuit, as is the case with incandescent lamps or transformers fully loaded with incandescent lamps, the energy is represented by the product of the volts and amperes, the factor being, of course, unity.

When, however, there is much reactance in the load circuit, as in the case of lightly loaded alternating-current motors, the generators and supply circuits must deliver the current required to energize the motor reactance as well as supply the actual power delivered by the motor. Thus, ignoring the motor losses, the volt-amperes supplied must be multiplied by a factor of 0.9, 0.8, or even 0.7 to determine the actual energy represented.

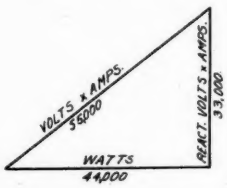


FIG. 1

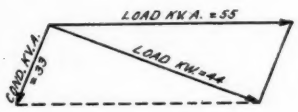


FIG. 2

FIG. 1. VECTOR DIAGRAM SHOWING VALUES OF ACTUAL WATTS, APPARENT WATTS AND REACTANCE

FIG. 2. VECTOR DIAGRAM SHOWING EFFECTS OF NEUTRALIZING REACTIVE COMPONENT BY MEANS OF A 33 KV.A. CONDENSER

To take a concrete example:

Amperes required by motor or feeder..100
Voltage of circuit 550
Wattmeter reading 44,000

The power-factor is, therefore, 44,000 divided by 55,000, or 0.8, as shown diagrammatically in Fig. 1.

In other words, the generator and the transmission lines, transformers, and feeders must in this case supply 25 per cent more volt-amperes than the motor (ignoring losses) turns into work. It must be borne in mind in this connection that the steam turbine or other prime mover has to supply only the actual energy, or in this case 44 kw., but the generator and lines must supply, with corresponding heating, line-drop, etc., the 55 kv.a.

It will be appreciated that any device which will neutralize the effect of the reactance will stop this drain on the supply system.

A static condenser has just this desired property, in that its current is leading instead of lagging, and if a 33 kv.a. condenser were connected near the load in the instance referred to above, the supply system would have to furnish only the 44 kv.a. required. This is shown in Fig. 2, the 33 kv.a. reactive component being neutralized by a 33 kv.a. condenser.

For a circuit having other constants, the size of the static condenser required to neutralize the reactance partially or completely is similarly determined.

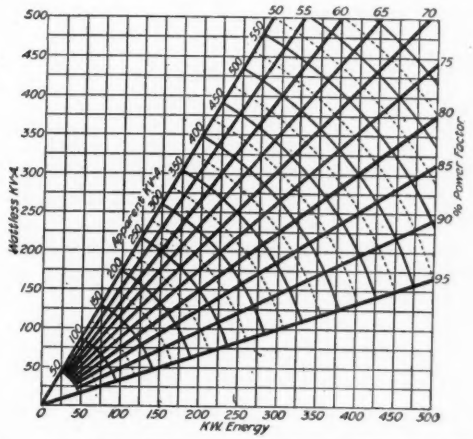


FIG. 3. CURVE SHOWING RELATION OF ENERGY LOAD TO APPARENT LOAD AND WATTLESS COMPONENTS FOR DIFFERENT POWER FACTORS

KV.A. CAPACITY SAVED BY CONDENSERS

FIGURE 3 was prepared from various commercial feeder constants, and reference to it gives the proper size of static condenser to produce various desirable improved operating conditions.

Thus, if a certain 500-v., a-c. feeder has a current of 500 amp., and the power-factor shown by the power-factor indicator is 0.60, the condenser required to raise the power factor to 0.70 will be found from the figure as follows:

Locating on the 0.6 power-factor line the point cor-

responding to 250 kv.a., it is noted that the wattless kv.a. is 200 and the energy kv.a. is 150. Now as the energy is unchanged, we note the intersection of the 150 energy ordinate with the 0.7 p-f. line and find that the wattless kv.a. for this value is 153. Subtracting 153 from 200 it is found that 47 kv.a. is the exact condenser kv.a. required to raise the power-factor of this circuit

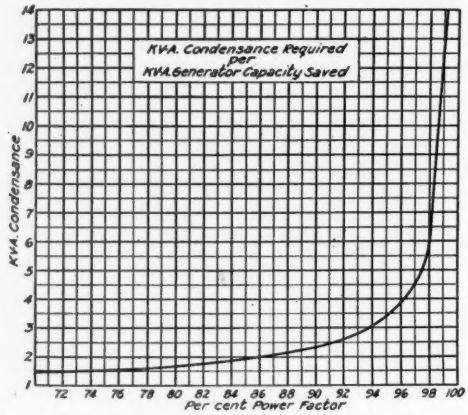

KVA. Condensance Required per KVA. Generator Capacity Saved
KVA. Condensance
Per cent Power Factor
72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
1 2 3 4 5 6 7 8 9 10 11 12 13 14

FIG. 4. KV.A. CONDENSANCE REQUIRED PER KV.A. GENERATOR CAPACITY SAVED

from 0.6 to 0.7; correspondingly the transmitted line kv.a. is, without change of energy, reduced from 250 to about 214, or over 14 per cent.

Likewise on this feeder

an 88 kv.a. condenser would raise p-f. from 0.6 to 0.8

or 127 kv.a. condenser would raise p-f. from 0.6 to 0.9

or 200 kv.a. condenser would raise p-f. from 0.6 to 1.0

These data tabulated are as follows:

Desired Power-factor Improvement	Required Condenser Kv.a.	Reduction in Line Kv.a.	Condenser Kv.a. per Line Kv.a. Saved
0.6— .7	47	36	1.3
0.6— .8	88	63	1.4
0.6— .9	127	83	1.5
0.6—1.0	200	100	2.0

As unity power factor is approached it will be observed that a relatively large amount of condenser capacity is required for a slight saving in line kv.a.

This is graphically shown in Fig. 4, indicating that on account of cost it is not commercially desirable to attempt to raise the power-factor of a circuit much above 0.90.

Decreased Line Losses

The decrease in feeder or generator kv.a. greatly reduces the line losses. For instance, comparing the 0.6 and 0.9 cases cited above, the line losses in the feeder between the condenser and the generator, being proportional to the square of the respective currents, would be in the relation of 500 squared (250,000) to 334 squared (111,556). The losses with the condenser in operation are therefore 55 per cent less than when no condenser is used, resulting in cooler feeders, transformers, and generators.

Improved Voltage Regulation

In the same manner, the voltage drop in the line is reduced to 33 per cent, thus increasing motor and lamp voltages and improving generally the regulation of the system.

A positive indirect improvement has been found in the reduced exciter current necessary to hold normal line voltage. Thus, one operator found that his exciter output when operating without condenser at a switchboard power-factor of 0.54 was 16.3 kw. When the condenser was thrown onto the circuit, raising the power-factor to 0.85, the regulator on the exciter reduced the exciter current so that only 12.8 kw. excitation was required, a saving of over 21 per cent.

Condenser Near Load

As the condenser reduces the line current between itself and the generator, it will be appreciated that the best results will be secured with the condenser con-

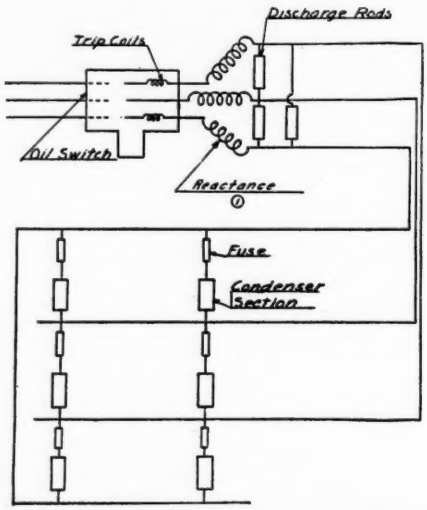


FIG. 5. DIAGRAM SHOWING METHOD OF CONNECTING CONDENSER SECTIONS TO LINE

nected near the center of the load and not near the generator.

A definite illustration may serve to emphasize the various features in connection with the installation of static condensers, showing the saving in generator capacity (most important at peak load) as well as the actual saving in watts lost in lines and transmission apparatus.

An electric light and power company or mill organization has its power house say one mile from the center of the load on a certain feeder. Various small amounts of power are taken from this feeder at points between the center of the load and the power house and beyond the center of the load, the circuit feeding 550-v. a-c. motors or other devices. The feeders are all 300,000 circular mil cable, two cables per phase being in parallel.

The management finds that the generators have to be operated at 639 v. to give 550 v. at the center of the load. They also find that the feeder requires 232 kv.a., the actual energy being only 153 kw.

At times of peak load the station capacity is severely taxed, yet with a growing demand for service the gen-

erators must be given some relief. As the relatively large investment for additional standard generators seems unwarranted, the two most promising methods are either the running in of a parallel circuit of 400,000 circular mil cable or the installation near the center of the load of a 75 kv.a. static condenser. The former of these methods, although reducing the line loss to 5.7 per cent, as shown in the following tabulation (the same value as secured by the installation of the condenser), only relieves the generators to the extent of 11 kv.a., whereas the static condenser method would relieve the generators of 60 kv.a., or about 25 per cent of their load.

Solution 1—More Copper

The additional 400,000 circular mil cables would cost approximately $4200, but the capitalized saving in line losses would be about $3600. But crediting the new arrangement with the 11 kv.a. generator capacity saved, at $10 per kv.a., the cost of the cable would therefore be $490 more than the benefit secured.

Solution 2—Static Condenser

The installation of a 75 kv.a. static condenser near the center of the load would cost approximately $1125. There would be a credit of $600 because of the value of

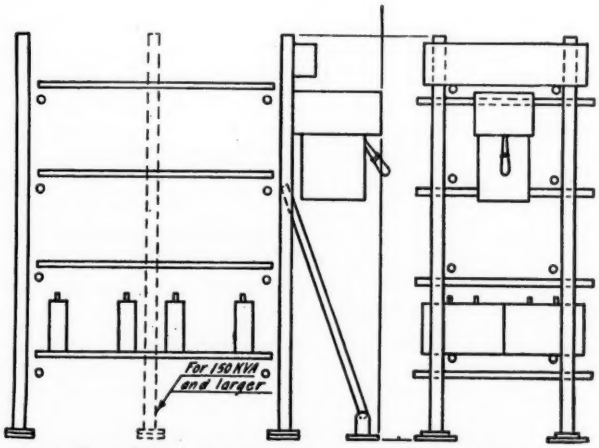


FIG. 6. METHOD OF MOUNTING CONDENSER SECTION

the generator capacity saved. The improvement in losses would be the same as with method 1, the net saving representing an investment of $3075.

As shown, the expenditure for cable with method 1 was $490 more than the benefit secured, whereas with the condenser there is a gain of $3075, making the condenser method under the conditions assumed more advantageous by $3565 than the cable relief method.

In the above typical case nominal values of interest, charges, etc., were assumed, viz.:

Value of kilowatt-hour.....$0.01
Hours operation per year.....7200
Interest rate.....10 per cent
Generator cost per kv. a. $10.00

Therefore it will be appreciated that for other conditions, values, etc., the net advantage of using the static condenser can be determined by substituting the new values in place of those used.

Even though the exact value of the energy saved is ignored in comparing solutions 2 and 3, it will be observed that the difference between the assumed cost of the condenser ($1125) and the value of the generator economy ($600) is $525. The difference between the cost of the lines ($4200) and the value of its generator economy ($110) is 4090. The financial advantage, therefore, of the condenser method is represented by the difference, or $3565.

The static condenser method is accordingly more advantageous by $3565 than the installation of additional cable to secure the same line loss under the conditions assumed.

General

Static condensers have no revolving parts and require practically no attention beyond the throwing of simple control switches.

The active materials of the sections are sealed in substantial tin boxes, approved enlosed fuses being used

OPERATING CONDITIONS WITH AND WITHOUT STATIC CONDENSERS

Case	1	2	3
Conditions	2-300,000 No cond.	2-300,000 and 1-400,000 No cond.	2-300,000 With cond.
Load			
Kilovolt-amperes	200	200	200
Power-factor	0.70	0.70	0.70
Kilowatt	140	140	140
Cond. Kv-a.	0	0	75
Transmitted			
Kilovolt-amperes	200	200	156
Power-factor	0.70	0.70	0.90
Kilowatt	140	140	140
Line Loss Per Cent	9.4	5.7	5.7
Generator			
Volts	639	608	609
Kilovolt-amperes	232	221	172
Power-factor	0.66	0.67	0.86
Kilowatt	153	148	148
Saving No. 3 and No. 2 vs. No. 1			
Generated Kilowatt		5.0	5.0
7200 hours at 1 cent		$360.00	$360.00
Capital at 10 per cent		$3600.00	$3600.00
Generator Kilovolt-amperes		11	60
Value at $10		$110.00	$600.00
Cost of New Lines		$4200.00	
Cost of Cond. at $15			$1125.00
Net saving vs. No. 1		$490.00 (More)	3075.00
Net advantage of condenser vs. additional lines			$3565.00

to connect the individual sections to their respective connection bars.

The individual sections are mounted on a pipe frame work using the general switchboard clamping devices, as indicated in Fig. 6. The illustration likewise shows the control oil switch mounted directly on the rack, and the series reactive coils just above the switch, and also the discharge rods, which in this case are mounted just above the sections.

The series reactive coils are used as a screen to exclude from the condensers any higher harmonics which may exist in the voltage wave or which may be impressed by line disturbances.

The discharge rods are placed across the various busbars so that when the oil switch is open the condensers will discharge through these resistances, and so return

to a neutral condition ready for the unit to be reconnected to the circuit.

Though condensers are designed for 24-hr. service, some find it advantageous to disconnect the units from the line at night, and reconnect them in the morning. The transmission lines are then not loaded up with high leading currents at night, with unnecessary C^2R losses, which are just as disadvantageous at night as high lagging currents are during the day.

The construction of the sections makes it possible to readily connect static condensers for single-phase operation or to arrange the active parts in groups for polyphase operation.

As is well known, the current in a condenser with a given voltage is dependent upon the frequency; therefore static condenser outfits become relatively expensive per kv.a. at frequencies less than 40 cycles.

Condensers can be built for operation at any commercial voltage, but it has been found preferable to use transformers or auto transformers for voltages below 1000 v.

Although there is no limit to the size of static condenser outfits, as this is merely a case of adding condenser sections to get the total kv.a. required, it has been found that most conditions are best taken care of by two or more units of the following capacities, which are considered the standard sizes.

255 kv.a.	200 kv.a.	150 kv.a.
100 kv.a.	50 kv.a.	25 kv.a.

—General Electric Review.

Experiences in a Country Power Station

By G. H. Kimball

"THAT board up there is some mess," said Hall, the electrician, to Wallace, the engineer, one night when things were quiet.

Then, before the engineer could make any reply, he added: "It is so near the wall and the wires are so closely packed in behind it that if anything ever happens, it will be some job to get at the trouble."

"Formerly," replied the engineer, "it was customary to install wires and other connections close together and with the lower voltage used, there was not so much danger as at present; but there are many plants that were built much later than this one where the same conditions prevail with regard to wires. It seems

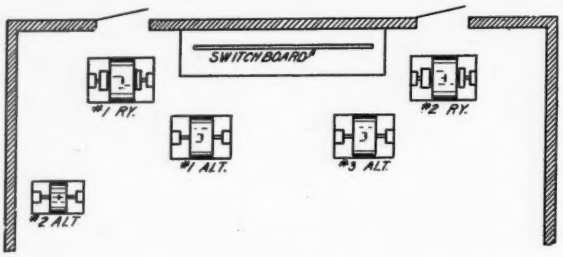


FIG. 1. GENERAL ARRANGEMENT OF THE PLANT AS SKETCHED BY WALLACE

to grow before the operators realize, to a crowded condition."

"How were they arranged up at the Glendale plant?" asked Richards, who had just finished examining the oil on one of the turbines.

"To begin with," Wallace began, "the original installation up there consisted of two 550-v. d. c. generators and three 2300-v. a. c. machines. The storage battery I have already described to you.

"To handle the work at that time required, besides the five generator and one battery panels, two railway feeder panels, two lighting feeder panels, and two street light feeder panels."

"How were the exciters operated?" asked Hall.

"Two of them were belt driven and the third was direct connected to the shaft of the alternator which was a very convenient arrangement. All of the generators you will recall were driven by belts from the jack shaft except one which was belted to an engine."

Richards, who was learning something of electricity, asked: "Did you run the alternators in parallel?"

"Not at that time," answered Wallace; "in small plants it was not considered necessary, for in a pinch one machine could carry all of the load. In the case of the alternators, however, we had double throw switches, one set of contacts being connected to one set of bus bars and the other set to a second set of bus bars. Two machines fed into the lower set of bus bars and one into the other. It was customary during the heaviest part of the lighting load to run two of the machines and throw the circuit switches so as to divide up the load. In case of trouble to one machine, we could throw over from that one to the other in a short time."

To make matters clearer, the engineer then drew the sketch shown in Fig. 1.

"This is a plan view of the arrangement of the generators and, as I have mentioned before, the only one that was independent of the jack shaft was No. 2 alternator."

"Why are they all so near the wall?" asked the oiler.

"To make the belt drive longer," answered Wallace, "but that also made a bad arrangement in another way that you may have noticed."

"Was it not hard to get things in through the doors?" asked Hall.

"Yes; exceedingly so, and it was usually customary to move large pieces through the windows which often had to be enlarged by removing some of the bricks. How much better it would have been to have had a large door in one place with plenty of floor space in front of it rather than the two that were there!"

After he had examined the sketch more closely, Hall asked which of the alternators fed into the same set of bus bars.

"Numbers 2 and 3," was the answer. "There were upper and lower sets, and No. 1 fed into the upper set and the feeder switches for the lighting equipment were as follows," and he made the sketch shown in Fig. 2.

Then Wallace explained as follows: "The town

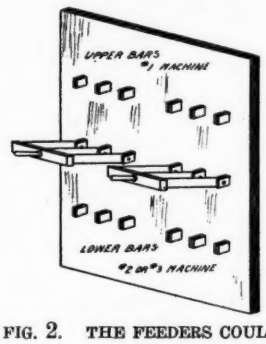
lighting system was supplied through four switches like these and you will see how they worked. It is not a good arrangement for heavy loads, as there is danger of arcing over and blowing fuses just at the time when you are in a hurry; however, it was considered good practice at that time."

"Was there no way that things could have been arranged so as to avoid all possibility of throwing No. 2 or 3 machine together?" asked Richards.

"Later," replied the engineer, "there was a small power station built about a mile down the river, the owners of which wished to sell us some of the surplus power so that when the wires came in from there we had three machines all connected to the lower bus bars and to make it impossible to throw them together by mistake we made up this panel," and he then drew a sketch (Fig. 3).

"This arrangement should explain itself," said Wallace, "for you will see where the wires from the three machines connected to the inside terminals of the plug switches and, as you will remember, when the plugs were out the circuit was broken, so with but one set of plugs, it was possible to have but one machine feeding into the set of lower buses at the same time."

"Did you ever get to the point when you had to



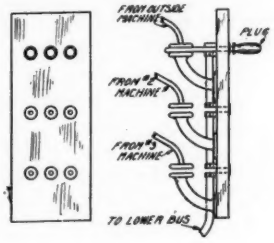


FIG. 2. THE FEEDERS COULD BE CONNECTED TO EITHER THE UPPER OR LOWER SETS OF BUS BARS

FIG. 3. PLUG BOARD USED TO PREVENT THROWING TOGETHER BY ACCIDENT OF THE THREE MACHINES

run the machines in parallel?" asked Hall, who had been silent for some time.

"Yes, it was not long after that when the manager began to plan to develop a water power privilege about 18 miles away where he expected to have three high-voltage machines that would feed into the line to our plant where the current would be stepped down to our voltage and then distributed to power users. In addition to this, he planned to install another alternator direct connected to a Diesel oil engine; gradually these things were accomplished."

"What did they do to the switchboard?" was the next question. In answer to this, the engineer drew the accompanying sketch, Fig. 4.

"To get more room, it was necessary to build an addition out in front of the station and this was directly back of the switchboard. After this was built, the apparatus was arranged as you see it here."

"Why is the trench made in the floor?" asked Richards.

"The transformers had cooling coils in them to keep the oil from getting too hot and the water pipes ran through it and also in case of the transformers boiling over, the oil and water would run out of the trench rather than on the board."

"What are the cells for?"

"They enclosed the 11,000-v. switches of which there were two, a very modest number compared to those in some stations. It is customary to put all such apparatus in fireproof cells so that it will be isolated from the other parts of the plant in case of a fire."

"Did you have any trouble with those?" was asked.

"In two instances, from the effects of lightning the heavy insulation on the wires caught fire from arcing across and the switches had to be repaired, but that was all. There is one point in operation any plant with bare copper wires running over the hill tops and making excellent collectors of electricity, that we do not have to contend with in isolated plants, and that is the effects of lightning; the sun may be shining where the plant is, but somewhere the line may project into the storm area and the effects will be felt with more or less violence."

Hall had noticed the three small transformers in the corner, so he spoke about them and Wallace said: "They are for stepping down the voltage to 220 for operating the motors for the compressor units and also

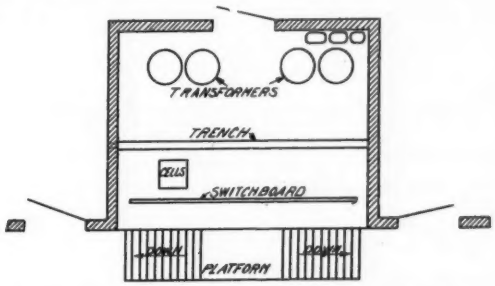


FIG. 4. PLAN OF SWICHBOARD AND TRANSFORMER BAY ADDED TO STATION

for a pump; we had two other motors in the plant, one being 2300 v. and the other, 500 v. d. c., driving an induced draft fan."

"Why were they not all a. c.?"

"The fan motor was put in when the plant was first built and I think the idea was to have power always available whether the machinery was rnning or not for it as they would from the storage battery which I have explained to you before. It was the same way in regard to the station lights, for most of them came from the railway circuit so that in case of accident you were able to have light."

"When the water plant supplying the high tension current was operating, could you run in parallel with them without any trouble?" asked the electrician.

"Yes, there was no difficulty either when running by steam or oil engines, or water power, and this was in spite of the articles that used to be published on the difficulty of paralleling alternators. There was one difficulty that kept us guessing for a time."

"What was that?"

"We had installed a main exciter unit in the Glendale station so that the smaller exciters were kept for emergency and we had also a voltage regulator that worked on the exciter field rheostat in such a way as

alternately to cut out and in parts of the resistance and it was done so quickly as to make the regulation of the voltage very good. In the other station, the same apparatus was installed but a mistake was made in wiring it so that if it stopped it was liable to kill the exciter at that plant and when this occurred it placed an overwhelming load on our machines and put them down and out. The first time it happened we had three generators in our plants on the line and suddenly the voltmeter hand began to go down and soon all of the machines were dead, which of course stopped everything else operated by alternating current. Also all of our motor driven auxiliaries stopped and we had to build up with one of the old exciters so as to get started again. At that time, we thought it was caused by a poor contact on our exciter rheostat; but it happened again the next day and later during the evening, which caused considerable complaint, so then it was decided that it was the regulator at the other plant and when this was cut out there was no repetition of the occurrence. Later, a man from the factory found that to be the trouble and he connected it up as it should originally have been."

"You spoke of a Diesel oil engine," said Richards. "Can you tell us something about them?"

"Yes, but not tonight," answered Wallace as he walked toward the turbines to see if they were all right to leave for the next watch.

Diesel Engine Drives Manteo

TUG BOAT DRIVEN BY 100-HP. ENGINE ON 2000 MI. TRIP AT 9.02 MI. PER HR. AVERAGES MILE ON 0.727 GAL. OF OIL

THE Manteo, a boat owned by the United States War Department, Engineers' Corps, is used in harbor and river improvement work on the Coast of North Carolina, acting as a tender to dredges and used for towing barges, shifting anchors, etc. The tug

FIG. 1. THE "MANTEO"

is 52 ft. by 13 ft., built by the Chas. P. Willard Co., Winthrop Harbor, Ill., in 1917 and 1918. The engine is a Fulton six-cylinder oil engine of the Straight Diesel type, built by the Fulton Mfg. Co., Erie, Pa.

The engine was shipped from Erie to Winthrop Harbor in July, 1917, but the boat was not finished in time to sail before winter. Before the engine was completely installed, the boat suffered an accident and sank. It was raised and towed to Kewaunee, Wis., where it wintered. In the spring, it was fitted out and the engine, which had been partly under water, was cleaned and cleared of the water which had soaked into the crank case. The Manteo sailed from Kewaunee on May 16, 1918, with Captain McDonald, Engineer Mac Gornto and the engineer from the Fulton Mfg. Co., H. Y. Jerman, who accompanied the boat only as far as New York.

During the runs from Kewaunee, Wis., to Erie, Pa., kerosene was used for fuel, as the captain was unable to obtain fuel oil. Only about 500 gal. were used. The mileage was 781 mi., covered in 74:54 hr. running time. This makes the consumption of oil 6 2/3 gal. per hr. Three gallons of Polarine oil were used and 5 gal. of 32c

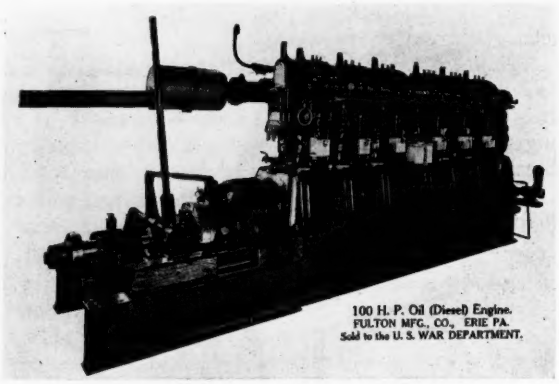


FIG. 2. DIESEL ENGINE FOR THE MANTEO

oil had been put into the engine base at installation and 5 gal. during the run; much of this still remained good. The Manteo followed the regular steamer course, out of sight of land much of the time.

On May 31, 1918, the Manteo left Erie bound for New Bern, N. C., via the Erie Canal and Hudson River, arriving at its destination on June 12, 1918.

This makes a grand total of 1993 mi. from Kewaunee, Wis., to New Bern, N. C., in 221 hr. The total amount of fuel consumed was about 500 gal. of kerosene and 949 gal. of fuel oil. Only about 25 gal. of lubricating oil were used. The average fuel consumption was 6.55 gal. per hour or 0.727 gal. per mile. The average speed through canals and all was 9.02 mi. per hr.

The engine is a Fulton six-cylinder, 8 by 9 in., four-cycle, oil motor of the straight Diesel type. It is unique in that it is the smallest straight Diesel type engine built of entirely American design and workmanship. The air compressor is mounted on the crank case and driven off the main engine shaft; it is of the two-stage type; a surplus of air is compressed and this surplus is stored in two steel bottles and used for starting; a smaller bottle contains the injection air which is held at a pressure of about 1000 lb. per sq. in. The reverse is operated by a Paragon reverse gear. It will be noted that the flywheel is at the after end rather than at the forward end. The operator standing by the reverse gear and flywheel can control the fuel oil to any cylinder. Each cylinder has its own fuel pump, a point of great advantage, because, when the operator wishes to run very slow and to save fuel, all he needs to do is to cut out the supply of oil to one or more cylinders.

Power Plant Records of Operation

REPORT SHEETS* DESIGNED TO AID ENGINEER IN OBTAINING AND MAINTAINING HIGHEST EFFICIENCY. BY RALPH E. TURNER

WHEN planning a system of records for a power plant the first thing to be considered is the purpose for which the records are to be kept. In general there are two objects in view, one to determine unit costs, the other to improve efficiency. The former may be called a record of costs and the latter a record of operation. Cost records are necessary to the owner, for upon these alone can he base intelligently his rates to consumers of his products. As a rule, these can be obtained by the installation of a few meters and the services of a clerk. The variation from day to day in costs is usually not very great, so that daily reports to the manager are not usually required; however, in all cases he will require a monthly report from which he will judge the economical condition of his plant.

Such a report is of little value to the man who wishes to analyze the losses of energy in a power plant. He must have a record of operation; the more frequently the readings are taken the more closely can he check the operating conditions and with greater surety can he apply remedies. The need for such close observation has caused the development of many instruments which show at a glance what conditions exist. In many cases an indicating instrument is sufficient for the operator, a graphic recording meter, however, is usually more enlightening and where quantities are concerned, integrating meters are essential if an adequate system of records is to be kept.

To plan a system of records that would be suited to all power plants would be impossible, in fact each plant requires some special consideration. The need, however, for a standard, or perhaps more correctly stated essential, system of operating records for power plants has recently been emphasized by the questionnaire being sent out by the U. S. Fuel Administration to all power plants of the country.

To supply such a need, the accompanying record forms have been prepared, and approved by Joseph Harrington, Administrative Engineer for the State of Illinois, which if correctly filled out will supply the administrative engineers with the information which they need in order to give the plant a rating and to suggest where conditions may be improved by a change in operating routine, additional equipment, repairs or improvements in design.

These forms, it will be noted, are planned to suit the needs of an isolated or small central station plant for the reason that all large public utility power plants already have elaborate systems designed for their particular equipment and needs. The forms can of course be extended to take in more apparatus, more frequent readings, also more cost data, but the general idea rather than a specific form is suggested here for the benefit of those who do not already have an adequate record system.

To take up more in detail the importance of and the advantages to be gained by keeping and analyzing a record of operation, the following explanation of the items to be recorded and the instruments desirable is given:

For most satisfactory operation of any steam driven machinery, constant unvarying steam pressure is desirable. In many plants the variation of as much as 5 lb. is made a cause for a reprimand, but in these plants the operators are provided with means for accurately controlling the pressure. For the measurement of steam pressure and safe operation of a boiler plant each boiler is provided with a steam pressure gage; these are invariably of the indicating type. Pressure on the steam header, however, is usually indicated by a gage on the gage board in the engine room and this is the instrument usually read for record purposes. If a graphic recording gage is installed it also is most conveniently located on the gage board. A convenient instrument for the boiler room force is a large illuminated dial type gage located over the firing aisle, capable of indicating only a short range of pressures in the neighborhood of the boiler pressure carried, but the divisions on the dial are large and easily read.

When the engines exhaust to atmosphere, little or no pressure should be indicated on the exhaust steam pressure gage, yet at times the exhaust pipe may become obstructed and go unnoticed were it not brought to the attention by an increase of pressure indicated on the gage. This is a call for immediate investigation and a prompt correction of the cause of increased exhaust pressure is the result of systematically reading and recording the indicated exhaust pressure.

The back pressure should be kept as low as possible when the exhaust is used in heating systems, but the amount may depend somewhat upon weather conditions and the type of heating system employed. Also in plants run condensing the maintenance of a constant vacuum is a delicate operation and with both these cases the exhaust pressure should be watched carefully. Indicating gages here are usually sufficient but recording gages give better opportunities for a study of related conditions and a means of checking up the operation by the man in the office.

Weather conditions affect so many operations in a plant that no record would be complete without some notation in regard to them. Natural draft is extremely sensitive to weather conditions; direction and velocity of wind, barometric pressure and temperatures all have their influence on draft and combustion. Where cooling towers are used, the humidity of the air, the temperature and wind have effects that reflect back upon the coal pile.

Probably the most important reason for recording weather conditions and outside temperatures is because of the effect they have upon the amount of steam used for heating. Many engineers secure the daily report of the local weather bureau for recording purposes, but where these are not available the necessary instruments would be a thermometer, a wet and dry bulb thermometer and a barometer. The record should state whether

*These blank report sheets may be secured from Power Plant Engineering at a price of $4 for a year's supply.

POWER PLANT DAILY REPORT

NAME _____ DATE _____ 19__

DATA	FIRST WATCH 7 A.M.	9 A.M.	11 A.M.	1 P.M.	SECOND WATCH 3 P.M.	5 P.M.	7 P.M.	9 P.M.	THIRD WATCH 11 P.M.	1 A.M.	3 A.M.	5 A.M.
STEAM PRESSURE - LB.												
STEAM TEMPERATURE												
EXHAUST PRESS. LB. OR VAC												
WEATHER CONDITION												
BAROMETRIC READING												
HUMIDITY												
TEMPERATURE OUTSIDE												
" BLDG. HEATING SUPPLY												
" " " RETURNS												
" HOT WATER SERVICE												
" BRINE ICE TANK												
" FEED WATER TO HEATER												
" " " " BOILER												
" COND. CIRC. WATER INLET												
" " " " OUTLET												
" HOT WELL												
" ENGINE ROOM												
" BOILER ROOM												
" FLUE GAS												
VOLTMETER												
AMMETER												
FEEDWATER METER	READING		USED									
LIVE STEAM TO HT'G. SYSTEM METER	"		"									

BOILER NO.	1	2	3	4	TOTAL OR AVERAGE	1	2	3	4	TOTAL OR AVERAGE	1	2	3	4	TOTAL OR AVERAGE
% CO_2 IN FLUE GAS															
DRAFT - INCH. WATER - UNDER GRATE															
" " " FURNACE															
" " " DROP THRU FUEL															
" " " DAMPER															
" " " DROP THRU TUBES															
BLOW-OFF OPENED - TIME															
" " DURATION															
COAL - LB.															
LB. COAL PER SQ. FT. GRATE															
ASHES - LB.															
STEAM FLOW - LB.															
RATIO = LB. STEAM ÷ LB. COAL															
PER CENT RATED CAPACITY															
BOILER CLEANED INSIDE															
FLUES SCRAPED OR TUBES DUSTED															
FIRES CLEANED															
WATER TESTED															

	START	STOP	HRS. RUN		START	STOP	HRS. RUN
ENGINE NO. 1				BOILER FEED PUMP NO. 1			
" " 2				" " " " 2			
" " 3				GENERAL SERVICE PUMP			
" " 4				VACUUM PUMP NO. 1			
FAN ENGINE NO. 1				" " " 2			
" " " 2				CIRCULATING PUMP NO. 1			
BOILER NO. 1				" " " 2			
" " 2				SUMP PUMP			
" " 3				VACUUM CLEANING MACH.			
" " 4				ICE MACHINE			
FIRE PUMP				COAL CRUSHER AND CONVEYOR			
ASST. ENGINEER							
OILER							
FIREMAN							
COAL PASSER							
OTHER LABOR							

	NEGATIVE YESTERDAY	NEGATIVE TO-DAY	NEGATIVE DIFF.	POSITIVE YESTERDAY	POSITIVE TO-DAY	POSITIVE DIFF.
WATTMETER - LIGHTS						
UNIT NO. 1						
" " 2						
" " 3						
" " 4						
POWER METER			KW.			

TOTAL COAL		LIVE STM. ON HT'G. SYST. - HRS.	
" ASHES		ICE PULLED - TONS	
WATER EVAPORATED			
EVAPORATION PR. LB. COAL			
COAL PER KW. HR.			
WATER PER KW. HR.			
COST COAL PER 1000 LB. STEAM			
TOTAL K.W. OUTPUT			

REMARKS, REPAIRS, ETC.

CHIEF ENGINEER.

FIG. 1. DAILY REPORT SHEET SUITABLE FOR MODERATE SIZE POWER PLANT (FULL SIZE SHEET)

the weather is fair, cloudy or stormy and wind condition, also the barometric reading and per cent humidity.

The pressure and temperature of the exhaust steam supplied to the heating system and the temperature of the returns should be watched carefully and compared with outside temperatures and the amount of return condensate or live steam used, as by this method the efficiency of the heating system can be judged. It would not be difficult after watching these conditions for a season to make a close estimate of the amount of steam that will be required when outdoor conditions are known; an increase of heating requirements above this estimate would indicate the need of an investigation.

To supply water hotter than necessary for lavatories is a waste of heat, so the temperature should be watched carefully. Also the temperature of the brine in the ice tank, where one is part of the power plant equipment, should be maintained at an even temperature to secure best results.

Upon the difference in temperature between the water entering and leaving the feed water heater, a definite idea of its efficiency can be had and a gradual decrease in this difference would indicate that cleaning is necessary.

The same may be said of the condenser circulating water and hot well temperatures. The degree of vacuum is also an indication here, and should be compared with temperatures and quantity of circulating water.

Temperatures in the engine and boiler rooms show in a rough way the efficiency of the heat insulating material used and a careful study of these temperatures in connection with boilers or engines in service may point to possible savings by cutting down radiation losses.

Flue gas temperatures may be indicated or recorded by high temperature thermometers or pyrometers and there is no more accurate method of checking the efficiency of heat absorption in the boiler than by carefully watching the flue gas temperature and comparing it with rate of combustion, gas analysis and rate of steam development. Dirty boilers, fallen baffles, leaky furnace and boiler settings, holes in fuel bed, overloaded or underloaded boilers all have their influence on flue gas temperature, making this item one of the most important to be recorded in a daily log.

With modern electric generators voltage regulation is very close, yet conditions sometimes occur that cause violent fluctuations in voltage and to hunt these causes a graphic recording voltmeter is most convenient, but if this type of instrument is not at hand frequent reading and recording of voltage will insure closer watch of conditions than if no readings were taken.

It is more important to read the station ammeter as this is a direct measure of the power load being carried. On this reading taken frequently, the engineer can base his program of operation as he will know how heavily loaded his generators will be at any period of the day under normal conditions.

A feed water meter is important as it gives the most accurate measurement of the amount of water evaporated that is ordinarily obtained in power plants. The principal discrepancy between water fed and steam developed is that wasted through the blowoff which can be estimated.

When live steam is used for heating purposes in addition to exhaust from the engines, a steam flow meter should be installed on the live steam line to give the amount of steam so used, which will vary with outside temperatures and the machinery in use.

The processes that take place in the operation of boilers are mostly chemical and physical with but little mechanical. It is therefore of advantage to examine each boiler separately as overall results do not point directly to the boiler that is not being operated correctly. The percentage of CO_2 in the flue gases points directly to losses that exist in many boilers and no record would be complete without this data. A hand operated instrument is inexpensive and easily operated but a recording analyzer has the advantage of giving continuous readings and will frequently point to inefficient methods used by firemen. A common practice is to have a recording instrument for the stack gases while a hand instrument is used on the individual boilers when over-all results indicate inefficient conditions somewhere among the boilers.

It will be noted that on the sheet we have provided space for only one reading on each boiler per watch. The plan suggested here would be to report readings for the different boilers at different hours during the shift, thus, in a plant of four boilers and an 8-hr. watch, take a sample of the gases every 2 hr., making one sample from each boiler during the watch. Of course when an investigation is being made on any particular boiler more frequent readings are necessary but for normal operation the above plan has worked well in many plants.

The same method of reporting draft conditions may be used as for recording gas analysis, but this does not imply that draft gages need not be observed more frequently than once during a shift. No other condition in boiler operation is subject to such rapid variations as the draft and the gages should have as close watch-

COAL RECORD

NAME _____ MONTH OF _____ 19__

DATE	TICKET OR CAR NO.	KIND	SIZE	MINE	DEALER'S NAME	DEALER'S WEIGHT	CITY SCALE WEIGHT	DIFFERENCE IN WEIGHT		B.T.U. PER LB.	PERCENT ASH	PERCENT MOISTURE	PRICE PER TON	COST
					BALANCE ON HAND FIRST OF MONTH		( )							

FORM APPROVED BY JOSEPH HARRISON ADMINISTRATIVE ENGINEER FOR ILLINOIS

TOTAL _____
COAL USED _____
BALANCE ON HAND _____

_____ CHIEF ENGINEER.

FIG. 2. REPORT BLANK FOR COAL RECEIVED DURING THE MONTH (FULL SHEET HAS 72 BLANK LINES)

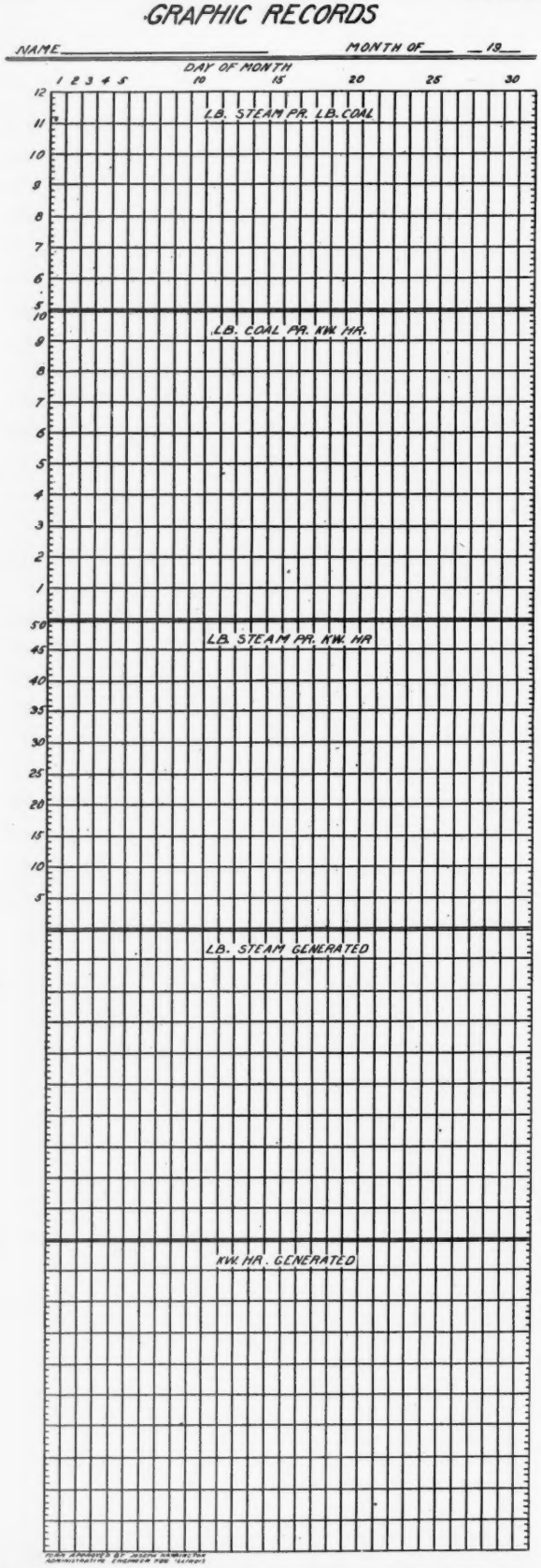


FIG. 3. BLANK CO-ORDINATE SHEET FOR PLOTTING DAILY VARIATIONS IN OPERATING RESULTS (FULL SHEET HAS SPACE FOR 10 CURVES)

ing as the pressure or water gages. The condition of the fuel bed, load carried, soot on tubes, fallen baffle walls, excess air in furnace, all show up directly upon the draft gages and the cause of draft variation can readily be detected by an engineer familiar with boiler plant operation. For best results these gages should be of the recording type.

The time of opening the blowoff valve and the length of time the discharge takes place is important as this work should be done during the period when least load is being carried and by knowing how long the valve is open an estimate of the amount of water wasted this way can be made.

Items regarding coal and ash weights are deter-

CONDENSED SUMMARY

NAME _____ MONTH OF _____ 19__

COAL USED		COST OF COAL	
WATER EVAPORATED		" WATER	
TOTAL KW. OR HP. OUTPUT		" OF LABOR	
LIVE STEAM FOR HEAT		" OF REPAIRS	
KW. OR HP. HR. POWER		" PR. KW. OR HP. HR.	
KW. HR. LIGHTS		" OF STEAM 1000 LB.	
ASHES MADE		" " SUPPLIES	
COAL RECEIVED		" " HEAT-LIVE STEAM	
COAL ON HAND			

OTHER SUPPLIES RECEIVED

IMPROVEMENTS AND NEW MACHINERY

CONDITION OF PLANT COMPARED WITH LAST MONTH

REMARKS

CHIEF ENGINEER.

FORM APPROVED BY JOSEPH HARRINGTON ADMINISTRATIVE ENGINEER FOR ILLINOIS

FIG. 4. MONTHLY REPORT SUMMARIZING RESULTS

mined by means of scales, and it is preferable to keep a separate record for each boiler as better control of the division of the load is then possible. Especially is this true when a steam flow meter is provided for each boiler. An integrating flow meter to record total steam developed is most convenient but in the absence of this a feed water meter is essential for making an estimate of the amount of water evaporated per pound of coal.

The effects of cleaning fires and blowing soot upon steam pressure, gas analysis, in fact the entire boiler operation, make it advisable to record the time when these operations are performed so that the engineer, while analyzing graphic records, will not be misguided as to the causes of fluctuations in conditions.

Other items in regard to boiler operation are self-explanatory except perhaps that headed "Water tested." In present day boiler practice it is considered most scientific to test boiler water for impurities as a guide for blowing down the boiler. This item assumes that this test is made at regular intervals and impurity recorded.

A record of the time of starting and stopping the various pieces of machinery in the plant is a guide to

the engineer in making out his program. This record should be compared carefully with the total load conditions. Frequently it is possible to arrange for the operation of auxiliary apparatus during the light load periods of the day and in this way build up the boiler load factor and efficiency. In this section of the record every important piece of steam or electric power using equipment should be listed.

The importance of holding each man responsible for certain work or machinery cannot be emphasized too strongly; it is therefore essential that a record of the men's names on each watch be kept for the purpose of checking up the quality of their work.

In the next section of the report should be given the totals for the day. It will be noted that three-wire generators are assumed with a wattmeter on each circuit. The advantage of having the two meters is for detecting unbalanced load conditions. From these totals can be calculated the curves which should be included with the monthly report.

As a monthly report we would suggest the use of three sheets. The first of these is the coal record, on which the data is recorded as deliveries are made. At the present time this report is extremely important and the report suggested here gives sufficient data upon which to start an investigation in case of difficulties in securing the proper amount and quality of coal at prices regulated by the Government. The blank implies that the coal should be analyzed which is, of course, the most satisfactory method of keeping the record, but if the name of the mine from which the coal comes is known the analysis and heat value can be fairly approximated by reference to Government Bulletins.

The second monthly report would consist of curves, preferably of the stair-step style, drawn from daily results. It should be kept up to date, the curves being plotted each day as the daily report sheet is handed to the engineer. Any marked variation from normal conditions will then receive immediate attention. On this sheet, five curves are suggested which seem to be the most important for the analysis of operating conditions, other values or conditions could readily be plotted from the daily report if the engineer in charge finds it desirable. At the end of each month it is well to plot the average across the chart to give a ready means of comparison with future daily records.

The third sheet of the monthly report is a summary giving totals and averages which are of interest to the owner or manager and gives the information usually required of the engineer by these officials.

IT IS the opinion of many oil men that the proposed war profits tax of 60 per cent applied to the sale of new oil wells to producing companies will result in stopping the business of oil prospecting, or "wildcatting." The prospector must take all the chances when drilling for a new oil pocket. If he loses, he is out 100 per cent of his investment. If he wins, under the proposed tax law, he must pay the government 60 per cent of his profits. The oil men claim that the reward, under this system, will not be sufficient to induce men to undertake new drilling; old wells are insufficient to supply the demand, and the result will be a famine in petroleum products, including gasoline and lubricating oil.

How Much Money Does a Soot Cleaner Save?

SOME interesting computations have recently been made available by the Vulcan Soot Cleaner Co., of Du Bois, Pa. They show that a soot cleaner saves much more money during its lifetime than is generally supposed.

Just at this time, when we are all trying to save as much fuel as possible, these figures are of especial value.

The computations have been simplified to "savings per ft. of pipe." Thus they find that each foot of pipe used in connection with a permanent installed soot cleaner saves approximately 18.3 tons of coal during the lifetime of the cleaner. In addition to that each foot of pipe saves one man's labor for one day. This makes it a simple matter for the reader to compute the savings that can be expected from each foot of pipe after the installation of the cleaner.

Since the average water tube boiler requires about 200 feet of pipe, it is not difficult to compute the total money saved, or the money saved by the reduction of labor cost alone. In some cases, it is found that the computed labor saving alone pays for the cleaners. The money saving due to the lower coal consumption is, of course, many times larger.

Wages at the present time are high, but if we assume that boiler room labor can be secured at $2 per day, the labor saving with the average cleaner is 2×200, or $400 for the lifetime of the cleaner.

As for coal saving, if we assume the price of coal to be $4.00 per ton and 200 ft. of pipe per cleaner, the money saving for the lifetime of the cleaner will be, in round numbers—

$$\$4.00 \times 18.3 \times 200 = \$14{,}600.00$$

Add this to the $400.00 obtained above and we get a total saving of $15,000.00. These figures vary, of course, with labor and coal-costs, but can be easily adjusted by the reader to fit his own conditions and thus determine whether or not a permanent installed soot cleaner would be profitable in his plant. These figures are based on boilers operated at 140 per cent capacity, average coal consumption 4 lb. per b. h. p. per hour, boilers operating 24 hours per day, 325 days per year.

It is also assumed in the above that the life of a cleaner is seven years which is claimed to be a very conservative figure.

A Flying Engineer

JUST commencing my sixth week here and have been flying the past three weeks. After having had 7 hr. 45 min. dual work, made my first solo last week. Great stuff!

The first trip up is a "jazz" or "see" ride; then in later trips up the cadet is given the "stick" and rudder control in the air, and next allowed to try "take-offs" and landings. The second week the cadet flies the ship most of the time, the "lieut." merely sitting in front and signaling corrections, occasionally taking the controls to let the cadet "feel" how a certain bank or movement is executed.

Next week we start on tight "8"s, spirals and get-

ting out of tail spins. The "lieut." will of course be up with us. Next some landings within 50 yd. of a fixed spot, side stepping into a field, cross country work and finally acrobatics.

The old reliable Curtiss training plane is used here. The field is 4½ miles from Americus, and just a mile from the Dixie Highway.

Last Wednesday the Americus Commercial Club gave an old-fashioned Georgia barbecue for us in a grove a short distance from here. They had broiled pig, Brunswick stew, pickles, tomatoes, bread, lemonade (15 wash tubs full) and loads of watermelons. And every time a call is made in town the host has a "melon cutting" on the back porch.

Prospects for going overseas in the very near future are not particularly robust. A recent statement claims that the U. S. at present has a sufficient number of pilots to man all the planes that can be produced up until a year from next October.

It is unfortunate that the Bristol planes were junked and that the De Havilands appears at present to fall short of requirements.

Flying cadet's pay was reduced last month from $75 to $33, and some growling resulted, but most of the boys growl from habit although cheerful by nature.

W. P.

(To the man on the ground, it is to wonder, after doing "Fig. 8's, spirals, tail spins and side stepping" what would be considered "acrobatics" in the flying service.—Editor).

The German Workday

AS AN example of German efficiency, the following proclamation, designed to secure labor for harvesting crops, is a good example.

Note the *inclusiveness* of the order; no source of labor power is overlooked. As everybody is to work a 16-hr. day, with 2 hr. allowed for meals, there is evidently 8 hr. allowed for sleep—if one sleeps in the field with his clothes on. Probably after 14 hr. work 7 days a week, he would be ready to do that. Time is allowed to eat meals, but none to prepare them. Probably the children under 15 yr. were expected to do the household work, care for cattle and the ordinary affairs of life.

Every person was made to count. There were no exemptions for age, sickness or condition. Those who refused to work were "detained in barracks" or "exiled to Holnon." From what is known of German methods with inhabitants of occupied territory it can easily be imagined what would happen to the men in barracks and the women in exile, and to both in prison.

As to children, nothing is left to imagination. A boy or girl of 15 yr. who had worked 14 hr. a day for 6 days, and didn't, for any reason, go to work on the seventh day, was to be flogged. For workmen the flogging is limited to twenty strokes a day, but there is no limit for children.

How would you like to see this sort of German efficiency applied in America?

Holnon, July 20, 1915.

All workmen, and women and children of 15 yr. and upwards, must work in the fields daily, Sundays included, from 4 a. m. till 8 p. m. (French time). A break is allowed of half an hour in the morning, one hour at midday, and half an hour in the afternoon.

Any breach of these regulations will be punished as follows:

(1) Men refusing to work will during the harvest be formed into labor companies and detained in barracks under the supervision of German corporals.

After the harvest those refusing to work will be sent to prison for six months; on the third day the rations will be simply bread and water.

(2) Women unwilling to work will be exiled to Holnon to labor.

After the harvest these women will be imprisoned for six months.

(3) Children refusing to work will be flogged.

The Commandant will, further, at his discretion order the punishment of refractory workmen with a flogging of 20 strokes daily.

The workmen of the parish of Veudelles are now undergoing severe punishment.

(Signature of the Commandant.)

To be posted in Public.

Relining Our Guns in France

ANNOUNCEMENT is made by the Ordnance Department of the approval of the plans for the manufacture of the machine tool equipment which the United States will install in France for relining the heavy railway mount guns of from 8 to 16 in. up to 50 calibers in length.

Owing to the tremendous heat generated by these guns when fired, their accuracy cannot be assured after a few hundred shots, unless they are relined. It was necessary, therefore, to establish a relining plant in France, where this work could be done.

The project for this relining plant is one of the largest undertakings by the Ordnance Department and will call for the expenditure before completion of from $25,000,000 to $30,000,000. The plant will be comparable in size with the Krupp Gun Works at Essen, Germany.

The machine tools alone required for this project will cost between $15,000,000 and $20,000,000 and embrace some 218 units, including gun boring lathes, engine lathes, rifling machines and grinders.

Included among the facilities required for the manufacture of these tools was a planer of unprecedented length—500 ft.—to cost $45,000. The largest planer previously built was 186 ft. in length.

The 500-ft. planer extends over such a length of ground that in order to insure its perfect alinement correction had to be made in the design to take care of the curvature of the earth.

The outstanding feature in the construction of these planers is the use of reinforced concrete for the bed plates. This results not only in a material reduction in the time required to build the all-important item, but also reduces the cost and saves iron for other war industries.

Likewise, the expansion and contraction, due to temperature changes, of an amount of metal represented by a wrought iron bed plate of these dimensions would seriously affect the alinement of the planer.

In addition to the machine tool requirements, there will be needed extensive shrinkage pits for heating the gun jackets in order to remove the old liners and insert the new ones; a full equipment of 240-ton traveling cranes; a steam-electric generating plant of approximately 5000 kw. capacity with its complement of boilers, pumps and other accessories, and the electric motors for driving the machines.

There will also be required extensive housing facilities for the equipment and the personnel to operate it.

The Ordnance Department has completed the engineering work on this whole project in less than thirty days from its inception. In that time the project has been reviewed and approved by the Chief of Ordnance, passed by the Clearance Committee of the War Industries Board, negotiations concluded with machine tool builders, and procurement orders issued for the production of the tools required. Under ordinary conditions the engineering work on a project of this magnitude would have required over four months.

The forgings for the reliners are obtained from the very best grade of crucible steel. They are heated, and forged, and turned to approximate dimensions over here, and sent to France, and will be turned to the proper dimensions in the plant "over there."

The relining of the big guns is one of the biggest parts of the war program which calls for delivery of these tools to the relining plant within a very short time, so that they may be used in relining the guns now in use by the American forces.

Regulation on Surface Type Condensers

THE WAR INDUSTRIES BOARD has decided that the surface type condenser shall be confined, for the period of the war, for use on shipboard, except where special permit is secured by the purchaser. Where possible, manufacturers will be permitted to fill orders for condensers with nonferrous tubes already contracted for up to January 1, 1919. On contracts after that date, manufacturers are urged to use steel tubes on condensers for land uses, and whether the order be for Government or civilian use, except for the Navy and Emergency Fleet Corporation, permit must be issued by the war Industries Board.

Seven Reasons Why Paper Must Not Be Wasted

THE GOVERNMENT'S requirements for all kinds of paper are increasing rapidly and must be supplied.

2. Paper making requires a large amount of fuel which is essential for war purposes. A pound of paper wasted represents from 1 to 3 lb. of coal wasted.

3. Paper contains valuable chemicals necessary for war purposes. Economy in the use of paper will release a large quantity of these materials for making ammunition or poisonous gas.

4. Paper making requires labor and capital, both of which are needed in war service.

5. Paper making requires transportation space. Economy in the use of paper will release thousands of freight cars for war purposes.

6. Greater care in the purchase and use of paper will save money. Your savings will help finance the war.

7. Strictest economy in the use of paper will prevent a shortage. —WAR INDUSTRIES BOARD.

Marching to Victory

(Dedicated to the National Army)

BY JOSHUA O'LEARY

Air, The Battle Hymn of the Republic

Our country calls, and in her cause we loyally unite;
Defending her from ruthless foes, we battle for the right.
Her banner bright we'll proudly bear triumphant through the fight,
To victory marching on.

Raise the battle cry of freedom,
Raise the battle cry of freedom,
Raise the battle cry of freedom,
To victory marching on.

With solid ranks and stern resolve, we're marching right along,
The day of victory dawns apace, our hearts are brave and strong,
No longer shall the nations be compelled to suffer wrong,
For right is marching on.

Raise the battle cry of freedom,
Raise the battle cry of freedom,
Raise the battle cry of freedom,
For right is marching on.

Remember Lusitania and all our martyred dead,
Remember streets with blood of babes and women crimsoned red,
Remember outraged nations that in freedom's cause have bled,
And march to victory on.

Raise the battle cry of freedom,
Raise the battle cry of freedom,
Raise the battle cry of freedom,
For victory, marching on.

The starry flag of liberty for battle is unfurled
Till the spirit of autocracy is banished from the world,
And tryanny from throne of might shall finally be hurled,
While justice marches on.

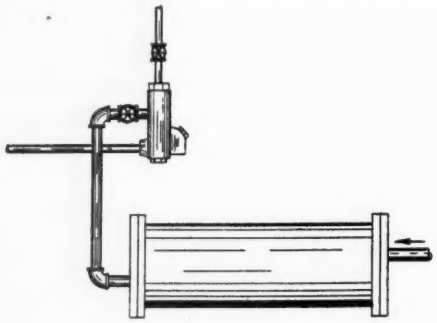
Raise the battle cry of freedom,
Raise the battle cry of freedom,
Raise the battle cry of freedom,
For justice marching on.

We fight the foes of freedom, and may God defend the right,
May the cause of human liberty be shielded by His might;
The War Lord must be broken and his armies put to flight,
Ere peace on earth is won.

Raise the battle cry of freedom,
Raise the battle cry of freedom,
Raise the battle cry of freedom,
Till peace on earth is won.

A Cure for Injector Troubles

WHERE WATER is supplied to injectors from city supplies or from a distant tank by means of a pipe line, trouble may often be experienced in securing satisfactory service because the injector loses its suction. Primarily this is caused by the sudden sucking up of the water in the pipe when pipe line is small or is overloaded the oncoming supply cannot carry itself to the injector quick enough to prevent a kicking and pounding action. Where the injector is thus piped up it is always advisable to install near the injector suction a reservoir of water to smooth out any momentary overload. Such a reservoir can be placed in almost any line by simply making use of a section of large diameter pipe and connecting it into the line by means of reducing flanges or couplings. A short piece of pipe about 4 or 5 diameters of the line, or a longer section one or two diameters



ENLARGED SECTION IN SUCTION PIPE CURES INJECTOR TROUBLE

larger will usually serve the purpose. This extra piping is well worth while in every case where the water comes to the injector under very little pressure, or where there is a long pipe line causing excessive pressure drop.

M. A. SALLER.

An Engineer's Examination

RECENTLY we accompanied one of our employes to the office of the district examiner of engineers in the State of Massachusetts, the applicant having made application for a second-class engineer's license, and the examination was conducted by three examiners.

The examination room was provided with a small return tubular boiler in partial setting with several attachments piped as shown in the illustration.

As will be seen, the boiler is piped for both power and low pressure heating. Some things are connected properly while others are not.

The applicant was asked to describe the operation of the steam pump, how he would set the steam valves and chase the water through the pump.

1. What is the effect on the engine's operation if we use the exhaust in the heating system and increase the back pressure?

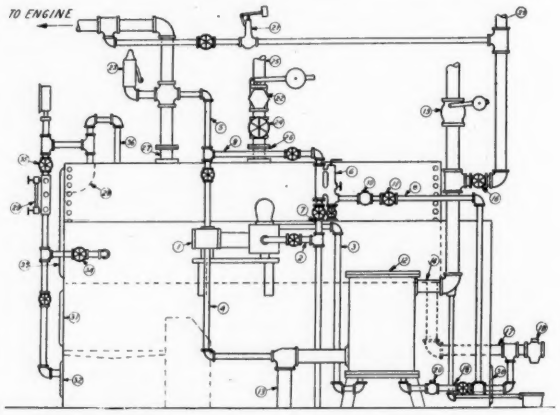
2. How can we increase the back pressure?

3. How much should it be increased?

4. Describe the operation of any shaft governor with which you are familiar.

5. How does it regulate the speed?

6. Which is better, to change the angle of advance or decrease the throw of the eccentric, and why?



1. Deane Simple Steam Pump
2. Suction Pipe Steam Pump
3. Discharge Pipe Steam Pump
4. Exhaust Pipe Steam Pump
5. Steam Pipe to Pump and Hancock Inspirator
6. Hancock Inspirator
7. Hancock Inspirator Suction Pipe
8. Hancock Inspirator Discharge Pipe
9. Hancock Inspirator Steam Pipe
10. Check Valve
11. Globe Valve
12. American Feed Water Heater
13. Exhaust from Engine
14. Exhaust from Heater
15. Back Pressure Valve
16. Globe Valve to Heating System
17. Blowoff from Boiler
18. Blowoff Cock
19. Feed Pipe
20. Check Valve
21. Mason Reducing Valve
22. Lever and Weight Safety Valve
23. Pop Safety Valve
24. Globe Valve
25. Riser to Heating System
26. High Pressure Nozzle
27. Low Pressure Nozzle
28. Dry Sheet
29. Water Column
30. Back Connection Door
31. Fire Door
32. Ashpit Door
33. Front Connection Door
34. Valve in Water Connection to Column
35. Valve in Steam Connection to Column
36. Pipe to Low Pressure Damper Regulator

SKETCH OF BOILER AND CONNECTIONS APPLICANT WAS ASKED TO CRITICIZE

7. In setting the cutoff on an engine with releasing gear and only one knock-off from the generator to steam valves, which end would be set first, and why?

8. Could you tell from the looks of an indicator card whether the engine is up to speed?

9. Suppose you take charge of a plant and are to begin Monday morning. Sunday you go in to look around. What would you examine?

10. Could you tell whether the engine would run away if released from its load?

11. What would you do if your B. & W. boiler had settled?

12. How would you know it had settled?

13. What might have caused it?

14. How would you put in a new tube, and what precautions would you take?

15. Examples were given to figure the safe working pressure of a tubular and vertical boiler; also strength of girth seam and ligament of a steam drum in a water tube boiler.

16. How would you know whether your flywheel was safe at the speed you are running it?

17. How would you start and stop an engine with an independent condenser, and under what conditions would you get water in the cylinder?

RECEIVER.

Conserving Ammonia

THE WRITER has worked about ice and refrigerating plants for the past 31 yr. and in that time has come across some bad propositions, especially the plant he is running at the present time. It was a fright the way the ammonia was going to the atmosphere. After the first day I repacked the ammonia rod; the head pressure was out of sight for refrigerating purposes, being at from 235 to 240 lb. per square inch.

I knew the system was full of air or noncondensable gas, so I set about rigging a cylinder of 4-in. by 4-ft. pipe with caps and supported it to the condenser house with clamps and holders. I started to purge daily for 20 days, in all 162½ hr. This season, I purged but twice, as I never let the gas pipe go over 80 to 100 deg. at any time; too high a temperature burns the life out the ammonia. So far this year we did not purchase or have any ammonia shipped to our plant, but last year 24 drums of anhydrous were put in the machine which is of 75 tons capacity. I also added this year 500 ft. of 2-in. coils to the system. We went through the hottest season in this section for the last 60 years, the temperature going for weeks from 96 to 105 deg.

E. W. H.

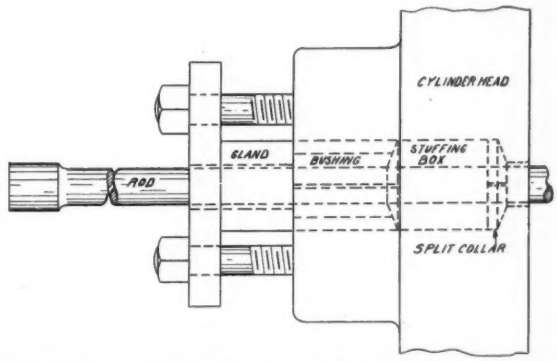
Novel Piston Rod Repair

ONE OF the large tube draw benches in the shop where I am employed recently broke. The piston rod, between the crosshead and the piston head, from some unknown cause, became badly scored. This rod is 3¾ in. in diameter and 14 ft. long and at one end is attached the piston head and at the opposite end the crosshead; on the crosshead is mounted the gripping tong.

How to make the repair in the shortest time possible was a question that caused the mechanical department to sit up and take notice. The following are a few of the details that were suggested and given careful consideration: (1) A new rod. This called for material, labor and time and would cause a long delay, besides there was no stock on hand large enough to make this rod. (2) Turn down the rod, bush the crosshead, and make a new stuffing box gland—more delay and labor. (3) Turn down the rod and make a new stuffing box gland. The job could not be done in this way because the new gland with its small hole would not pass over the large (crosshead) end of the rod. There were other ways and methods brought up and considered, but each was turned down for one reason or another.

The machinist who suggested the way by which the repair was finally made is an overgrown boy, but a reader of technical journals and a student. He knows how to do things in a pinch because he reads and learns what is being done by others; in other words, he's a student and mechanic. Here is how the job was done: The rod was turned down from 3¾ in. to 3½ in.; this was the least the rod could be turned down and a smooth surface obtained. The ends of the rod that fitted into the piston head and the crosshead were not touched. The old brass gland was bored out as shown in the sketch and a new bronze bushing (split) was made to fit the hole in the gland. The split bushing was bored to fit the reduced piston rod. Turning the piston rod down made it ¼ in. smaller than the hole in the cylinder head at the back end of the stuffing box, but this was corrected by means of a split bronze ring inserted in the stuffing box. When the rod was turned and everything was ready the assembling was done in the regular way as before the accident happened.

Assembling and adjusting the repaired gland was a simple job. The old brass gland without the bushing



ARRANGEMENT EMPLOYED TO PROVIDE FIT FOR TURNED DOWN ROD

was passed over the (crosshead) end of the rod; next the split bushing was placed around the rod and then slipped into the hole in the old gland. The job is now ready for the final assembling and fastening in the regular way.

I consider this method deserving of notice not only by machinists but by power plant engineers as well.

M. E. DUGGAN.

Temperature of Furnace Air and Flue Gases

IN R. TAYLOR'S criticism, page 721 of the Sept. 1 issue, he questions the correctness of my following statement which appeared in an article under the above heading:

"Inasmuch as 0.24 B. t. u. is required to raise the temperature of 1 lb. of air one degree F., it is evident that much of the heat value of the pound of coal is lost in simply bringing the temperature of the cold air up to the temperature of combustion. For each degree (0.24×18) 4.32 B. t. u. are lost. For each 100 deg. 432 B. t. u. are lost. If the heat value of the coal is 10,000 B. t. u., this preheating therefore represents a loss of $(432 \div 10{,}000)$ 4.32 per cent."

Mr. Taylor's contention is that I should have said, "this preheating therefore represents a *gain of* 4.32 per cent."

It all depends, I presume, on one's method of looking at it. If the coal itself is depended upon to do the

preheating, as is usually the case, the 4.32 per cent can be considered a *loss*. If waste chimney gas or other heat is utilized in doing the preheating it can be considered a *gain*. On reading over my statement carefully together with Mr. Taylor's letter I conclude that it would have been more technically correct had I ended the first sentence as follows: "much of the heat value of the pound of coal is lost in simply bringing the temperature of the cold air up to the temperature of the exit gases." There is no loss in preheating air after the temperature of the exit gases is once attained.

Air is generally preheated by the fuel itself in the natural process of combustion. It *must* be preheated up to the ignition temperature or there will be no combustion. It is well known, for example, that if hot burning gases are allowed to come in contact with the cold boiler tubes combustion ceases and the unconsumed soot adheres to the tubes or passes up the chimney.

If a special preheater is used which raises the tempreature of the fresh air up to the ignition point it is perhaps incorrect to speak of further "preheating" beyond that point. Combustion occurs *after* the ignition point is passed during which process the combustible gas increases its own temperature until combustion is complete.

The formula $\frac{T-t}{T}$ is not strictly applicable to steam boiler furnaces on account of radiation. An intensely high initial temperature is not always desirable because it is liable to cause clinker and other troubles. Hence it has been found that by so designing boilers that heat from the fuel bed is radiated into the heating surfaces the furnace temperature is considerably reduced, the chimney gas temperature reduced, and the boiler efficiency increased. The book "Finding and Stopping Waste in Modern Boiler Rooms" pages 105 and 106 shows how it is possible for the furnace temperature to be 2605 deg. F. without radiation or 2330 with radiation, yet the total heat given off by the fuel may be the same in each case.

On page 722 of Power Plant Engineering, Mr. Taylor says: It follows that there must be some point at which the boiler can be operated most economically; that point must be determined by actual test and will depend upon many variable factors, chief among which is the rate of air supply." In connection with this statement the following quotations from page 206 of the above mentioned book will be of interest:

"As the velocity of the gases over a heating plate increases, the true boiler efficiency at first drops, and then, after the gases exceed a certain velocity, it remains nearly constant.

"Experiments on a laboratory boiler showed that as the initial temperature of the air was increased, the rate of absorption increased, but not in proportion to the temperature. This indicates that the density of the air, which varies inversely with the temperature, influences heat absorption. When the initial temperature of the air was constant, the quantity of heat absorbed increased almost directly with the weight of air passing through the boiler. This fact is important for boiler practice. When the initial temperature was constant, as the quantity of air increased, the temperature air leaving increased to a certain constant temperature."

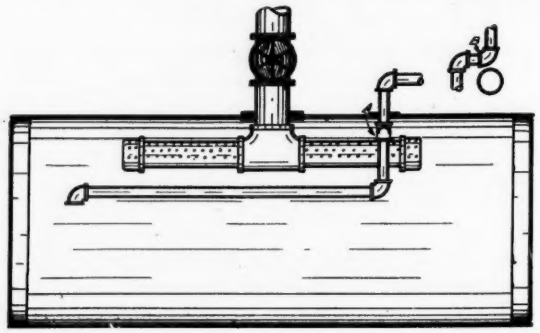
In the same book, page 201, are some interesting figures from a test of an air heater at a mill in Ireland. The air leaving the heater was reduced to 343 deg. F. The atmospheric temperature was 66 deg. F. The heating value of the coal was 11,252 B. t. u. The overall efficiency obtained was 81.2 per cent.

The writer is mentioning these things principally to assist in increasing interest in the coal saving movement. Much is still to be learned about boilers but enough is known now to save the millions of tons of coal needed by the civilized world today. The losses mentioned by Mr. Taylor are important and should be seriously considered. But "considering" is not enough. They should be *acted* upon.

W. F. SCHAPHORST.

The Consulting Engineer's Ingenuity

IN THE SKETCH shown herewith is the recommendation of a consulting engineer who gained his title through his "drag" with the general manager. The feed line shown at A has been formerly connected in the front head of the boiler by the C. E. instead of consulting



ARRANGEMENT OF PIPING ADVOCATED BY CONSULTING ENGINEER

with the chief engineer who could have informed him of the presence of a dry-pipe inside the boiler directly beneath the entrance of the new feed line. The hole was reinforced and tapped for the feed line when he discovered the dry-pipe. To overcome this obstacle, he had the mechanics run a long thread on the pipe entering the boiler on the end of which was screwed an elbow, a 6-in. nipple and the other fittings as shown to come out over the top of the dry-pipe. Eventually this misfit elbow at B is going to fail, as the long running thread has not a taper fit to conform with the threads in the elbow and the arrangement will drop off in due time in which case the engines and other auxiliaries will be getting water instead of steam unless some boiler inspector discovers it in time. This should impress the engineer; when taking charge of a new job, one of his first duties should be to examine the inside of his boilers at his earliest possible convenience. As the boilers are the most important of all his responsibilities, needless to say this bogus C. E. did not retail his title long after the general manager left the employ of the company; but the emphasis is to be on guard against previous ingenious accomplishments, when taking charge of a new plant.

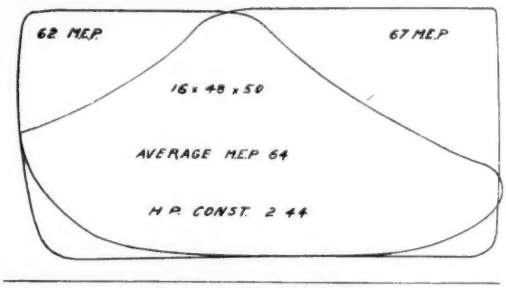
JAMES G. SHERIDAN.

An Old-Timer Still in Service

THIS card was taken from an old type of Green engine of unknown age, and while it does not look like good valve setting, it is not so bad when the circumstances are considered. The regulation was very bad, having the old-time Green governor attached to the ceiling and ½-in. round leather belt running up to it; it was ramming and hunting badly, also there was no three-way cock for the indicator pipes, these two last faults having much to do in getting equal cards from any engine. The engine dimensions are 16 by 48 by 50, with a horsepower constant of 2.44 and a mean effective pressure of 40; the power delivered is 97.60 hp., but it is at present overloaded, carrying a load of 156.16 hp.

This engine is wearing out its third set of boilers and has been started up six times in 15 yr. because of changes in ownership of the plant. Shortly after this card was taken the defective crankpin broke off and the cylinder head was knocked out and the piston crushed into crumbs, but the engine was soon repaired and is again on its way doing a good job.

This engine formerly carried more compression, up



CARDS FROM AN OLD GREEN ENGINE

to 75 per cent of boiler pressure, but had difficulty in pulling this load. After the compression was taken off it would carry the load very much better with less steam pressure.

A. C. WALDRON.

CO_2 Per Cent Doubled in an Hour

I AM NOT much of a hand for writing testimonial letters, but I made a test yesterday that just goes to show how easy it is to save coal if you put your mind on it and have the aid of Vulcan appliances.

I stopped in at the Y. M. C. A. College, as I had promised the engineer that I would help install the gas analyzer I sold him two weeks ago along with a draft gage. They have two Scotch marine boilers with McMillan furnaces and they had always considered their plant pretty efficient.

He had the draft gage already connected when I came and it showed about three-tenths of an inch draft. He had fixed the pipe to which he could attach the gas machine and so we were all ready to start taking the first sample of gas.

This showed that he was getting 4 per cent CO_2, instead of the 14 per cent that he confidently expected. The figure appeared to be too low so we took another sample, but it showed the same. I then traced the pipe back to where it was getting the gas and found that it was too close to the damper. I shoved it in a little further and took another sample. This showed a trifle over 6 per cent and although we took a number of samples at intervals of two or three minutes, the figure stood at the same mark.

A peek into the furnace showed bad holes in the fire. I smoothed these over with a poker, making the fire bed as even as possible and then took another sample of gas. This showed that he was now getting 8 per cent CO_2 so we began to look around for something that would increase the percentage still more. His draft still stood at three-tenths of an inch and we began experimenting with the damper. We reduced the draft a trifle and took another sample. This showed a little better than 9 per cent, so we knew that we were on the right track. We reduced the draft to 0.015 and the next sample jumped the CO_2 to above 11 per cent.

Not getting it above this point, we looked for other causes and found that there were air leaks around the plate in the rear of the boiler. The furnace setting was far from being air-tight and these leaks probably accounted for a considerable per cent of waste.

The steam gage before we started to take a sample of gas said 60. When he got through it showed 85 lb.—this increase of 25 lb. was without adding a single lump of coal.

On the basis of 11 per cent CO_2, the engineer sat down and figured out how much coal he could save in a month. When he got through he announced the result as 56 tons. As the instrument cost him $35 and the draft gage $16, you see that he saved the price of the instruments in about a week. This is what it does in a small plant and it is easy to figure what it will do in a plant where the coal consumption runs much higher.

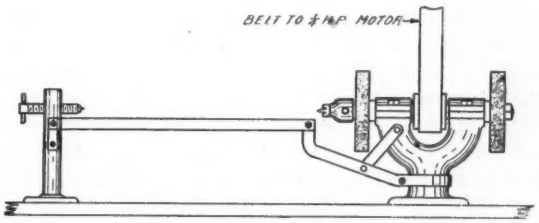
Yours very truly,

LOUIS SIMONS.

[Later when the air leaks had been thoroughly stopped and further attention had been given to the draft and fire, the average reading of CO_2 ran near the 14 per cent mark—and there it has continued to stand, simply because boiler room efficiency had been brought up to a high degree and engineer and firemen have learned what was possible.—Editor.]

Home-Made Lathe

IN THE OFFICE building where I am employed we required a few new rollers for a tank that the janitors use in wringing out mops. Prices were asked for new rollers and the figures submitted seemed excessive.



GRINDER HEAD FITTED WITH LATHE PARTS

I am submitting a sketch of a turning machine I fitted up which did the work very well and without any cost to speak of.

I sawed off the end of a socket wrench which fit the

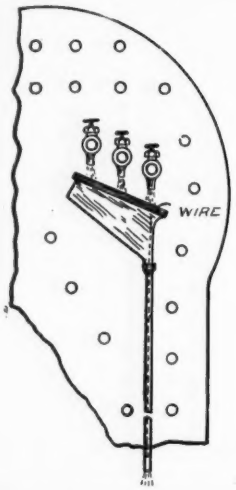
nut on the end of the grinder head, drilled and tapped a hole through the end of the wrench and the nut which held it securely. I left stock enough on the wrench to drill a hole and saw the sides out, which left two sharp jaws; I then drilled for a center pin.

A stand is made out of 1½-in. pipe with flange, drilled and tapped for center pin which is adjustable as to length.

The rest attachment was made to fasten to the stand and grinder head. T. P. F.

Keeping the Gage Cock Trap Pipe Open

THE TRAP pipe of boiler gage cocks frequently stops up, and has to be taken down to get the obstruction loosened by poking a wire through it. The writer after cleaning one out a number of times tried the following: A long steel wire was cut the length of the pipe and trap and bent over the edge of the trap in the form of a handle. The next time the pipe showed signs of stopping up, the wire was raised up and down until the pipe was cleared. The wire is, of course, left in the trap and



WIRE ARRANGED TO KEEP GAGE TRAP PIPE OPEN

always there when needed. It is practical only where there is a straight pipe into the ash pit below, but it might be of interest to some who have to open up traps of this nature frequently. F. W. B.

A Slide Rule Kink

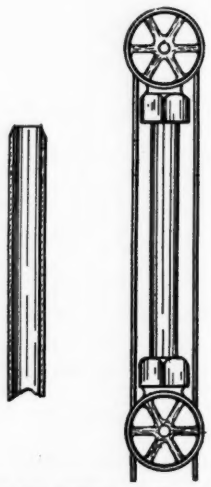
WHEN YOU READ of a rule regarding the number of figures to point off on your slide, you either make a mental note of it, or else forget it entirely. I have one and have put it where it cannot be lost. Between the left-hand index and the end of the rule there is quite a little space; also on the right-hand, on both of the fixed scales. At the left-hand end of the top scale I put the letter 1, and at the right-hand end of letter S — 1. Just to one side of the middle index I put the letter M. On the lower scale at the left-hand end, the letter D + 1, and at the right-hand end D. Just opposite 3.1416, I put the large letter D. I will now explain the meaning of the letters and their use.

On the top fixed scale, M stands for multiplication; S for sum, and S — 1, sum minus one. The sum is equal to the number of digits in the numbers, as in the case of 43 × 62, there would be two digits in 43 and 2 in 62, therefore a total of 4 digits in the answer. With S — 1, as in 43 × 21, there would be 4 minus 1 or 3. The large D means division and the end D's mean difference and difference plus 1, as for instance: 40 divided by 20 equals 2, there being 2 digits in each leaving 0 and adding 1 makes 1 digit in the answer. Also 20 divided by 5 equals 4, this being 2 digits minus 1 digit, equals 1 digit in the answer. One thing more and that is, if the index on the C scale is pointing toward the S or D + 1 end, your answer in digits will be governed accordingly. Also when at the S — 1 or D, it will govern by these symbols. As these symbols practically apply to the C and D scales, they can also apply to the A and B by a little thought.

DEAN B. COBB.

Some Gage Glass Phenoma

NOT LONG AGO, I put a new gage glass in new fittings, and it tested out all right, but in about 2 hr. I heard a sizzling, and examination showed that the glass had split up the side from bottom to within 2 in. of the top. Why



GAGE GLASS WORN SHARP AT ENDS

the glass did not break off at the end, as is the usual difficulty, I have been unable to reason out, and would like the opinion of others in this regard.

On another occasion I took out the glass from its fittings on a boiler, because it was so dirty I could not see the water. I found the ends were worn down as sharp as a razor all the way around, as is indicated in the accompanying sketch. The rubber gaskets were very free to move around on the glass and came out of the nuts easily. The reason for the glass wearing out in this way, at both ends, is another question which I should like discussed by readers of Power Plant Engineering.

R. G. SUMMERS.

BUY LIBERTY BONDS! Buy them now. Buy to the limit of your means—and more.

Go in debt for them—but buy, and do your part to hasten the victory that will bring our boys home again.

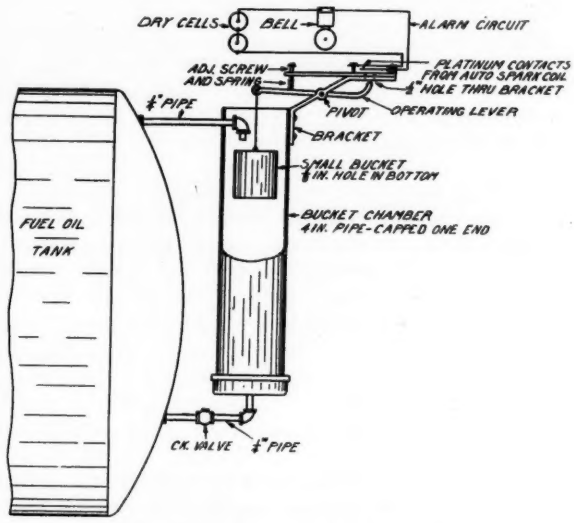
Don't make excuses—make sacrifices.

Fuel Oil Tank Alarm

SHOWN HEREIN is a sketch illustrating an overflow alarm which I installed on a fuel oil tank after having considerable trouble due to carelessness of the operators and after experimenting with various makes of floats which we found more or less unreliable.

Essentially this alarm consists of a length of 4-in. pipe supported and connected to the tank in the manner shown and housing a small bucket having a ⅛-in. hole drilled in the bottom. As the bucket descends, due to the weight of the oil with which it becomes filled, it causes the closing of a bell circuit through the medium of two platinum contacts taken from a Ford automobile coil and mounted on a bracket attached to the 4-in. pipe by means of small screws.

No switch is employed in the bell circuit so as to safeguard against the bell being disconnected. Any-



CONSTRUCTION OF FUEL OIL TANK ALARM AND METHOD OF APPLICATION

way, this is not necessary, as the bell will cease ringing as soon as the bucket chamber has filled to the level of the liquid in the tank, which period is about 1 min., giving sufficient time to warn the operator of the tank's condition.

H. G. MCQUEEN.

Plan for Listing Unused Equipment

I AM OFFERING to the readers of Power Plant Engineering for suggestions and criticism, the following idea along conservation lines.

Having been employed in power plant work for some years, I have been brought to realize how difficult it is, especially under present war conditions, to get material and supplies for power plants, and believe the following plan, if properly worked out, would greatly facilitate power plant work, and aid in the conservation of iron and steel, as also all other material used in general for power plant supplies, and labor of manufacture, etc.

Have all plants in each state, or if thought to be more practicable, in smaller districts, make a list of all supplies and material on hand, for which they have no immediate use, such as valves, pipe fittings, belting, pulleys, motors, pumps, etc., and mail to all other plants in their state or district.

There are few plants that do not have a variety of such material on hand, which can only be considered as useless, as far as their needs are concerned, while some neighboring plant might be saved considerable expense and trouble by having a list at hand of what could be purchased from near-by plants.

At the end of each week, or as often as thought necessary, all plants should plan to make a list of all material that had been disposed of, and mail to each plant in their state or district for their future guidance. Prices of such supplies and materials could be controlled by catalog list price of manufacturers.

I have used power plants in illustrating this idea; but it could be applied to other industries, such as laundries, mines, refineries and packing houses.

GEO. H. RENDLEMAN.

Discussion on Chain Grate for Wood Burning Desired

IN THE June 15 issue there was an interesting discussion on feeding shavings to boiler furnaces.

I am burning wood and find it getting so high priced and difficult to obtain, that I am naturally looking for some cheaper kind of fuel.

In this state we have a great many saw mills which waste or burn a large quantity of trimmings, trash and sawdust; if this would be burned under boilers with the aid of a chain grate, it seems that the cheapness of fuel would offset the high cost of grates.

In regard to its burning, a long grate would be necessary so as to dry fuel, the fuel being fed on the grates by hand. It seems to me that a chain grate would be useful in burning almost any fuel, from sawdust to coal or wood, as the speed and draft could be regulated.

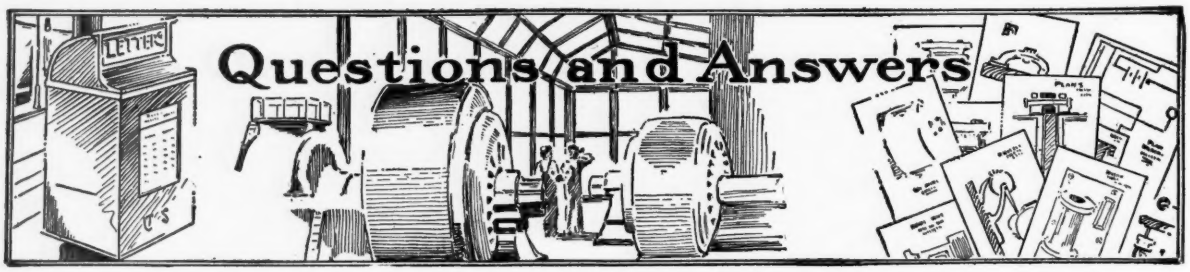
Any discussion or information that engineers may present upon this subject will be of interest to me.

F. B. K.

INCREASING the world's wheat supply is now one of our most urgent problems. Consumption of wheat per capita has been steadily increasing in most countries for the last 25 yr., and population has also increased. The present conditions are such that, allowing the same amount of wheat per person as was used before the war the yearly crop is not sufficient to meet the demand.

Either wheat production must be increased, or consumption be reduced, and this not only for the period of the war, but permanently. Consumption can be reduced by the substitution of other grains, as is being done in war bread, and it is likely that we shall all remember the lesson we are now learning that the use of a considerable amount of coarse grains is healthful as well as economical.

On the other hand, experiments in England have shown that the use of nitrate of soda, 5 cwt. per acre, increased the yield of wheat from 11.9 bu. to 36.4 bu. an acre. By the use of some 12,000,000 tons of nitrate of soda a year, the world's wheat crop can, therefore, be increased to meet the demand, and the problem becomes one for the chemical engineer to solve.



Boiler Room Questions

EXPLAIN how two or more boilers, which are allowed different pressures, are connected to a common steam main, and all safety valves are set at a pressure not exceeding the lowest pressure allowed. How do they pipe it up?

2. Why is it not safe to have too large a drip in main steam drum?

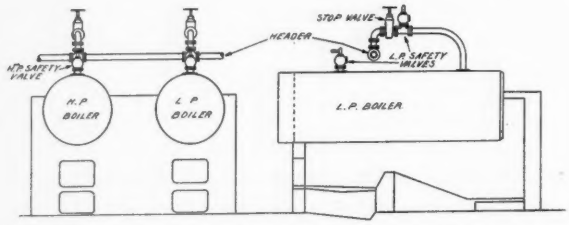
3. How can you tell when a right and left is steam tight without putting steam into it?

4. How would you shorten the stroke of a Blake condenser pump, horizontal type? J. M.

ANSWERS

THE enclosed sketch shows the connection of the auxiliary safety valve to the low-pressure boiler of a pair, which are connected to the same main and which have the safety valves for different pressures on the individual boilers.

The requirements in Massachusetts are, that this valve shall be put on the connection from the low-pressure



AUXILIARY SAFETY VALVE CONNECTION FOR HIGH-AND-LOW BOILER INSTALLATION

boiler to the main; that it shall be set at the same pressure as the valve on the low-pressure boiler, and shall be of a size to have the valve area equal to that of the connecting pipe, or if the pipe is larger than the steam main, shall have an area equal to that of the main. The idea is, that the valve shall be able to discharge all steam that can get to it from the main, in case the pressure of the main rises higher than that in the low-pressure boiler.

2. Too large a drip in the main steam drum may, if opened quickly, reduce the pressure in that drum in such a way as to cause a rush of steam into the drum. This would tend to result in priming at the boiler, also would cut down pressure so that it might affect the apparatus supplied from the drum.

3. As to the getting of a right and left coupling tight,—the method recommended is to screw the coupling first on to the right-hand end, and count the number of turns required to force it up hand-tight. Take it off and screw it on to the left-hand end, counting the turns in the same way. If it screws farther onto one end than the other, enter that end by the difference in the number of turns between the two ends, to get the coupling hand-tight. Then enter the other pipe and screw up to a tight joint. This will not prove that the joint is steam-tight, but it will come as near as possible to getting both ends of it steam-tight. We do not know of any way to prove that the joint is steam-tight except to turn out steam.

4. In the Blake condenser pump, horizontal type, the length of the stroke is regulated by the lost motion between the two tappets on the horizontal rods on top of the pump. To shorten the stroke, move these two tappets nearer together.

Charging a Storage Battery

INFORMATION is desired regarding the charging of a Willard storage battery, capacity 5 amp. for 22 hr. Ampere charge rate start, 13½; finish, 4½.

It is marked on the battery plate as above.

I have wired for 10 lamps in series as in Fig. 28, page 534 of the July 1 issue, and am using seven 16-c.p. carbon filament lamps.

After charging for 12 hr. find no change in the battery.

Am using 110 v. taking from the mains at the switchboard and have no ammeter on the battery line.

It is a three-cell battery and the first cell test 1150, second 1165 and the third 1175. G. T.

A. You speak of connecting 10, 16-c.p.carbon lamps in series, according to Fig. 28, page 534 of the July 1 issue.

If you will study that figure, you will see that these lamps are connected in parallel, not in series. A series wiring of 10 lamps would mean almost no current whatever through the battery. A 16-c.p. carbon filament lamp, at 110 v., takes about one-half ampere current. Ten of these will give, therefore, when connected in parallel, approximately 5 amp. of current.

According to the tests on your battery, the first and second cells are about ¾ discharged, and the third cell, a little less. They should, of course, be charged as quickly as possible up to a gravity of between 1275 and 1300. Charging at 5 amp., with the 10 lamps in parallel, it will take you about 30 hr. to charge the battery, but with the battery as low as it is, it would be well to start at this low rate and charge it for at least 10 hr. at the low rate. You could then charge at a higher rate by putting on more lamps in parallel.

Starting with 13½ amp. and finishing with 4½,—assuming that the heavy charge is carried on for, say, 6 hr. and then gradually cut down,—it is planned to

take from 10 to 12 hr. to charge the battery. After you have run for 10 hr. at about 5 amp., you could then raise your charging rate to 10 amp. by putting in 20 lamps in parallel, and run for 5 hr. more, then cut down to 5 amp. again and run for about 3 hr., which should give you a full charge.

While the cells are nearly alike at the present time, it may be probable that you will want to change over your connection and give the first and second cells a little stronger charge than you do the third, in order to bring them up to equal gravity. We trust that this will solve your trouble.

Size Generator for Boat

WE ARE figuring on installing an electric lighting plant on our boat, which will require about 175 lamps. We have quite a lot of electric welding to do, winters, on our boat, so we want a plant large enough to generate power for welding. What size generator would be required?

Later on, we may install wireless telegraph, using the same generator. F. N.

A. Figuring that you will want 175, 40-watt lamps, at 110 volts, you would need a 10-kw. generator to take care of these.

As to the size generator required for doing welding, this depends on the kind of welding that you would use. Assuming that you would use the arc welding, which is done by use of a carbon or metal electrode, the carbon arc will require about 50 v., and approximately 500 amp., while the metal electrode requires about 30 v. and 150 amp.

For doing the welding, it would be necessary to use either a motor generator to reduce the voltage to that needed on the arc, or, if this is for temporary work, it will probably be cheaper to waste the energy required to take current through a resistance, which can be made of iron wire wound on a piece of wood covered with asbestos.

For the metal electrode process, it will take about 4.5 kw. at the arc, or, including the resistance to cut down to 30 volts from 110, it will require about 16.5 kw. capacity of the generator.

This would probably be ample for any wireless telegraph apparatus that you might install, provided you do not want to burn all your lights at the same time that you are using the wireless.

Size Wire for Electric Heater

I WISH to heat a room 7 by 9 ft. and it gets as cold as 18 deg. below zero in winter; voltage 220, amps. 5, what size wire and how long would it have to be? May any kind of wire be used? F. B.

A. The amount of heat required for your room, assuming that it is 8 ft. high, and that ⅓ of the area, approximately, is glass, would be 24,800 B.t.u. per hour. Five amperes, at 220 volts, will give you the equivalent of 3756 B.t.u. per hour, which, as you will see, is only little more than 1/7 of that needed to heat the room in 18-deg.-below-zero weather. In other words, it would be necessary to use about 40 amp., instead of 5 amp., through your resistance to give you the required heat.

The resistance required for iron wire to carry 5 amp. at 220 volts would be 44 ohms. Number 15 iron wire, mounted in a wood frame, so that air can circulate around it to carry away the heat, will carry 5 amp., and it will take about 2000 ft. of this wire to make 44 ohms.

To give you 40 amp. at 220 volts, you would need about 5.5 ohms. To carry this current safely, you will need two No. 8 wires wound in parallel, and each wire will have to have 11 ohms resistance. For No. 8 wire, it takes 250 ft. per ohm, or 2750 ft. for 11 ohms, so that to get your 40 amp., you would need 5500 ft. of No. 8 iron wire wound two in parallel.

Criticism of Corliss Engine Cards

PAT'S Allis-Chalmers Corliss engine cards submitted for criticism on page 726, Sept. 1 issue, are without doubt good cards except that the steam line to cutoff inclines downward or wiredraws, as he states there is 90 ft. of steam main from boiler to engine; but as this main consists of 8 and 10-in. pipe, it seems ample for a 22 by 42 and 120 r.p.m.

It must be remembered that this piston speed is 840 ft. per minute, which is going fast for an engine so far away from the source of steam supply, and no doubt this piston is running away from the steam pressure (as we say), causing the steam line to cutoff to fall downward. One thing is certainly needed, however; that is, I would advance the eccentric so as to be sure a good ample opening is had. This will increase the compression, which is already sufficient, but by changing the exhaust links the compression may be made to suit the case. When we measure the height of the steam line and find with a 70-lb. scale it shows only about 65 lb. of steam at admission, and the boiler pressure is 90 lb., the steam drop between boiler and engine is plainly 25 lb. No wonder the cards show wiredrawn.

A. WALDRON.

Remedy for Trap Trouble

IN REFERENCE to Operating Engineer's trap troubles as related on page 727 of the Sept. 1 issue, it would be easier to suggest a remedy if the make of trap were known, as some buckets tilt, being connected by various means to the valve, while others raise vertically without links or hinges.

I suggest, first of all, that he remove the bucket from the trap and test for buoyancy by placing in water, a test which will also show whether any leaks are present. If it floats, which it must do if leakless and lighter than the amount of water it would displace, the trouble must be due to friction of some parts. The guide, if a linkless trap, may be encrusted with hard mud; or if on exhaust steam, oil may be mixed with the sediment. In any case, it should be thoroughly cleaned.

Inspect all joints of links or hinges to be sure they are working freely and after cleaning, a small amount of *fine flake* graphite rubbed on the pins will aid easy operation.

I believe the trouble, if bucket has not holes, is solely due to friction caused by sediment.

HARRY H. YATES.

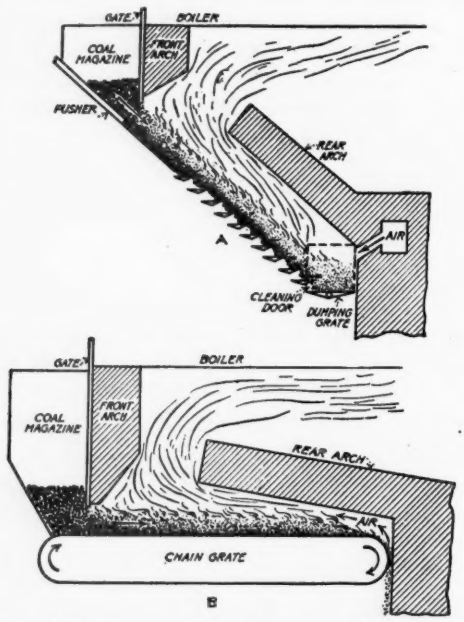
A WAR SAVER is a life-saver.

Burning Lignite

SPECIAL GRATE AND FURNACE FOR INCREASING TEMPERATURE AND COMBUSTION RATE

INFORMATION on this subject given by the Bureau of Mines in a paper by Henry Kreisinger is likely to be of interest the coming winter in view of the probable scarcity of coal and need for utilizing all available fuels.

North Dakota lignites especially are difficult to ignite on the ordinary flat grate, and even to keep burning. As there is some 35 per cent of moisture, it takes twice as much heat to raise it to ignition temperature as for bituminous coal, hence an inclined grate has been designed, with an ignition arch sloping in front of it at a distance of 12 in. from and parallel to the grate. The grate slopes at about 45 deg. to the horizontal, bars being horizontally arranged in step form and mounted so that they can be rocked. Wide air spaces are provided, also additional air is admitted through a clean-out door at the bottom of the grate. At the bottom is a dumping plate, 6 in. wide, with ¼-in. holes spaced ⅝ in. apart.



EXPERIMENTAL FURNACES FOR LIGNITE

Fuel is fed from a magazine by gravity, the grate being given an inclination that will cause gravity feed, which may be accelerated by rocking the bars. Thickness of fuel bed is controlled by the opening of the gate to the magazine.

At the top of the inclined ignition arch a throat 6 in. wide is provided, leading to the combustion chamber.

A dead plate, at the top of the grate, provides for drying of the lignite, but has no air supplied, as fuel is not to be burned on it. Rate of air supply is controlled at the lower end of the grate, the air passing up between the fuel bed and the arch, thus mixing with the gases from the fuel.

With draft of 0.1 to 0.15 in. of water, a bright fire was maintained, and with fuel broken to 2 in. the feed was nearly automatic. Slack in considerable amount appeared to cause no trouble.

A similar construction was tried for chain grates, with grate horizontal and an arch, slightly inclined, covering the grate from back to front, leaving a narrow throat at the front end. It is thought that inclining the grate 20 deg. to the horizontal would have given better results, as scrubbing action of the air on the upper surface of the fuel bed would have been more effective.

The Value of Pride

BY NORMAN EWING

ACCORDING to the laws affecting the classification of engineers throughout the country, they are rated as first, second and third class men, and this rating is based upon the man's ability to answer one of the respective examinations before an inspector or board of examiners.

In this article, however, I am going to put aside the above method of classification, and reclassify men into two distinctions, namely, the good and bad class; for most men are bound to be in one or the other, no matter what license they possess. Most men who hold a first-class engineer's license assume that they are good men on that account, and, as a matter of fact, they should be; but as the license does not make the man, a good many of them who have been fortunate enough to "get by" the examiner are far from being good.

Then arises the question, "what makes the good man?" Well, there are things besides technical skill and experience which go towards the making of a good man, and one of the most important essentials along this line is a man's personal pride and interest in the work which may devolve upon him. Do not, then, make the mistake of judging a man solely by his license, as a great many do, but give him a fair trial to see, by his actual work, whether or not he is qualified to hold down the job. Then you can much more easily determine the correct ability of the man. If the examinations given were more extensive, and took a man into the test of his practical abilities as well as the theory, I believe that there would be fewer first-class licenses issued than there are under the present system. How many men give pride a thought and stop to weigh up the value of it towards their making good? Very few, in my opinion; but, on the other hand, most men are prone to be satisfied with the old "don't care" system of running things, and as long as the plant runs at all are deceived into thinking that they are holding down their jobs and assuming a great responsibility, when in reality they are not doing their duty at all. At this most critical time, we should put into practice the system that will tend to improve the run of things in general, towards the accomplishment of economy of the highest degree, which is very important. A certain class of men take more pride in a pay check than in anything else, and especially when it comes to their work they look at it as a secondary matter. When men take a keener interest in their work and possess more pride in carrying out their duties, the better will conditions become in general and perhaps our pay checks would grow larger.

From the general appearance of a man's work, the

intelligent onlooker makes up his mind as to the real making of the man whom he may be sizing up, and no matter how many licenses he may have on the wall, if pride has been omitted from his practice, then he has not made as good an impression on his visitor as he would have otherwise. Thus it is best to keep the power plant in a respectable condition as well as a running condition, and it is perhaps well to say that, without the former method, the latter would be very inefficient.

Pride keeps a man ahead of his work instead of his work ahead of him. When the general conditions about the power plant are kept up to the top-notch degree of efficiency, it is pride which has played no small part in the production of that result; for where it is not practiced, you generally will find extravagance, filth, no degree of interest, and everything that tends to ruin efficiency of operation, bound to prevail. On the other hand, men who are classed as possessors of more pride in their work are the ones who make a good showing for what they do and generally convince the boss that they have at heart the interests of the company, and perhaps they receive a raise in salary without asking for it. There is a wide field in which price can find practice among engineers throughout the country, if the men will better consider the value of it and use it. If, however, they do think that they are good men, they may become better men by so doing. The man who calls himself a good engineer and lets his plant run in any way at all and who tolerates the unnecessary accumulation of filth and careless attention to his machinery, simply exposes his lack of interest and pride and is certainly no man to have charge of modern and up-to-date power plant equipment. Where pride plays no part in the operation of the plant, a poor example of an engineer is generally found, simply because laziness is the reason why, when the man seems to lack it.

It is then needless to say what sooner or later becomes of the man who has the disease called laziness; besides, it is absurd to think of the machinery under his care receiving any proper attention.

In order to clear any misunderstanding on the part of the readers of this article let it be understood that the writer does not mean to insinuate that pride alone can produce the best man, without considering the necessary technical skill and experience, for the two latter qualities are essentials, but the main thing to be remembered is that with the two latter and without the former qualifications the engineer may be less valuable. No matter how skillful the engineer may be, he generally is subject to betterment, and in taking pride in his work he may better his own character as an engineer.

Let it behoove more men, then, to couple with their daily performances in the plant pride and a keener interest in the work they are expected to do, which at this time, when the government is appealing to us to produce to the highest degree possible, a matter essential to the winning of the war. The engineer who practices PRIDE and takes thorough interest in his daily performances as an engineer, not only is worthy of being classed as a good engineer, but should be called a "genuine engineer," whose services at this important time are invaluable.

New Engineering Building for New York University

THE FACULTY of the New York University School of Applied Science is preparing to enlarge the equipment of that school in order to make provision for more extensive co-operation with the government in war service and reconstruction service after the war.

Chancellor Elmer E. Brown, of the university, and Dean Charles H. Snow, of the School of Applied Science, have called the attention to the serious national question caused by the falling off in the student enrollment of all technical schools. The apprehension of federal officials, from the President down, is no less grave than that of responsible educators.

The project includes the erection, at an early date, of a new building to be devoted entirely to engineering training. The building is to be erected on the site recently acquired through the generosity of Mrs. Russell Sage, and it is estimated, will cost at least $150,000. The present structure, despite the fact that in 50 yr. of its existence it has sent forth engineers who have taken a conspicuous part in many big projects, leaves much to be desired for the proper training of the engineering students of today. The Federal Bureau of Education, in a recent report on the school, said: "The chief marvel in studying the situation is that so much has been accomplished with such inadequate facilities."

The new building will contain 12 lecture rooms, 20 laboratories and 18 offices. In the basement will be the heat engineering laboratories. The wings at the extremities of the basement are to be used for the heavy machinery required in hydraulics, electricity and testing the strength of materials. A stairway at the end of the basement will lead to an extension that will contain shops and a power plant. A sub-basement will be used for boilers, pumps and accessories.

A vestibule flanked by administrative offices forms the central feature of the first floor plan. An assembly room equipped with a moving picture booth and facilities for technical lectures of any character is to be at the rear.

The wings on the first floor are devoted to hydraulics and electricity. The portions of the building between the wings and the central feature provides offices, smaller laboratories and classrooms. The first floor plan is typical of the two floors above it.

The second floor will also contain faculty and committee rooms. The third floor will contain a museum, library and study room, this latter providing accommodation sorely needed for students who do not reside on the university grounds.

Attendance at engineering schools has dropped 35 per cent, according to Dean Snow. Many third year and fourth year students have left the classrooms, and the number of graduates last June was far below the average.

Sixteen technical universities were recently questioned by the Federal Bureau of Education as to their financial deficits. Eleven reported substantial deficits, and others expressed grave doubts for the future.

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A Message from Woodrow Wilson, President of the United States

Again the Government comes to the people of the country with the request that they lend their money, and lend it upon a more liberal scale than ever before, in order that the great war for the rights of America and the liberation of the world may be prosecuted with ever increasing vigor to a victorious conclusion. And it makes the appeal with the greatest confidence because it knows that every day it is becoming clearer and clearer to thinking men throughout the nation that the winning of the war is an essential investment. The money that is held back now will be of little use or value if the war is not won and the selfish masters of Germany are permitted to dictate what America may and may not do. Men in America, besides, have from the first until now dedicated both their lives and their fortunes to the vindication and maintenance of the great principles and objects for which our Government was set up. They will not fail now to show the world for what their wealth was intended.

Intensive Training Must "Carry On"

Because of war requirements, intensive training is today recognized as a vital necessity in practically all branches of the national service. Courses a few months long are turning out commissioned officers to meet heavy responsibilities, and it is one of the most glorious pages in our history which records how these duties are being performed. Forced education is to be seen in the fitting of radio operators for sea duty, in the development of engineers for the merchant marine, and in numerous other phases of war and industrial work bearing upon the successful carrying forward of the cause of Liberty. All this is necessary, and it is to the credit of instructors and students alike that the results are so fine, but a word of warning, especially to young engineers, should be said.

There is no short cut to any real depth of professional status in engineering occupations. Without in the least belittling intensive instruction, it must be acknowledged that it can only give its recipient a fair start toward the intelligent performance of his daily duties. If he stops studying at the close of one of these rush-order courses, it matters little in what line, the chances of his becoming a first-class man in his specialty are thereby greatly reduced. On the other hand, there never was so great an incentive as now to continue hard study after getting into active work, whether in the field, in the engine room or in the laboratory. Personnel is changing at a rate far in excess of civil "turnovers" during peace times. There is a very wide appreciation of this among the young men in the army and in the navy, and the amount of hard study being given to specialties in the service by men who have entered these places after periods of short but rigorous instruction would pass all estimates, if it could be known.

The embryo plant engineer, whether ashore or afloat, will do well to realize that only the rudiments of his profession can be taught him in a few months; only enough, in fact, to fit him to handle mainly routine matters under the direction of others. But if he will summon the persistence to keep up hard study along with his practical service, whether at the front in Eu-

rope or behind the industrial supporting lines in America, he will combine his training and resources to utilize most efficiently one of the greatest opportunities for personal advancement, if not the greatest, indeed, which ever came to the young men of this nation.

Power Plant Location

Economy in the use of fuel and the uses of its products is apparently changing some of the old rules which have grown to be almost axiomatic in engineering practice. It has been customary to locate power plants and central heating plants at the center of gravity of their load. Now comes Charles P. Steinmetz with a new rule, not, however, new in practice, published in the General Electric Review. Stated briefly, it is "burn the fuel wherever heating is required, but first take out its available high-grade energy, and collect it electrically."

Evidently Mr. Steinmetz, whose keen, analytical insight into engineering problems has won for him a world-wide reputation, is an advocate of the block heat and power plant as outlined in our issue of Sept. 15 as opposed to the separated steam heating plant and the use of central station power where both power and heat are required. We quote below a portion of his article on "America's Energy Supply" dealing directly with the question of transforming low-grade heat energy into high-grade electrical energy:

"We realize that our present method of using our coal is terribly inefficient. We know that in the conversion of the chemical energy of coal into mechanical or electrical energy, we have to pass through heat energy and thereby submit to the excessively low efficiency of transformation from the low-grade heat energy to the high-grade electrical energy. We get at best 10 to 20 per cent of the chemical energy of the coal as electrical energy; the remaining 80 to 90 per cent we throw away as heat in the condensing water, or worse still, have to pay for getting rid of it. At the same time we burn many millions of tons of coal to produce heat energy, and by degrading the chemical energy into heat, waste the potential high-grade energy which those millions of tons of coal could supply us.

"It is an economic crime to burn coal for mere heating without first taking out as much high-grade energy, mechanical or electrical, as is economically feasible. It is this feature, of using the available high-grade energy of the coal, before using it for heating, which makes the isolated station successful, though it has every other feature against it. To a limited extent, combined electric and central steam-heating plants have been installed, but their limitation is in the attempt to distribute heat energy, after producing it in bulk, from a central station. Here again we have the same rule; to do it efficiently, do it electrically. In the efficiency of distribution or its reverse, collection, no other form of energy can compete with electric energy, and the economic solution appears to be to burn the fuel wherever heating is required, but first take out its available high-grade energy, and collect it electrically.

"Assume we use 200 million tons of coal per year for power, at an average total efficiency of 12 per cent, giving us 24 million kw. (referred to 24-hr. service) and use 200 million tons of coal for heating purposes, wasting its potential power.

"If then we could utilize the waste heat of the coal used for power generation, even if thereby the average total efficiency were reduced to 10 per cent, we would require only 240 million tons of coal, for producing the power, and would have left a heating equivalent of 216 million tons of coal, or more than required for heating. That is, the coal consumption would be reduced from 400 million to 240 million of tons, a saving of 160 million tons of coal annually.

"Or, if from the 200 million tons of coal, which we degrade by burning for fuel, we could first abstract the available high-grade power, assuming even only 5 per cent efficiency, this would give us 10 million kw. (24-hr. rate), at an additional coal consumption of 10 million tons, while the production of the 10 million kw. now requires 100 million tons of coal, more or less, thus getting a saving of 90 million tons of coal; or putting it the other way, a gain of 9 million kw.—12 million horsepower 24-hr. service, or 36 million horsepower for an 8-hr. working day.

"It is obvious that we never could completely accomplish this; but even if we recover only one-quarter, or even only one-tenth of this waste, it would be a vast increase in our national efficiency.

"Thus the solution of the coal problem; that is, the more economic use of fuel energy, is not only the increase of the thermodynamic efficiency of the heat engine, in which a radical advance is limited by formidable difficulties; but is the recovery of the potential energy of all the fuel, by electric collection."

Be a Bond Salesman

HELP UNCLE SAM IN PLACING THE FOURTH LIBERTY LOAN QUICKLY

ORGANIZATION has been perfected to raise the quota of each county, city and town during the first few days of the drive. The idea is that one patriotic citizen should not have to solicit bond subscriptions from another equally patriotic. Each should voluntarily subscribe for the largest amount he can buy.

Everyone is able to buy bonds the first day of the drive as well as he is the last day. A man is given only one day to vote, and only one day was required to register 13,000,000 men for the draft. Why should a man take more time to decide to lend his money to his country than he does to pledge his life in its service?

First, buy at once, to the limit of your ability. Then urge all your friends to do likewise. Don't wait for a solicitor to ask you. Go to your Liberty Loan headquarters; turn in your maximum subscription at once. Ask your friends to go with you, and thus make this a real volunteer loan, which will forever answer the Hun slander that "the American people are not behind the government" in this war to free the peoples of the world from the tyrrany of military autocracy.

THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE, Washington, D. C., reports that a man in Senegal desires to purchase small electric light and power plant. Catalogs and price list should be submitted. Quotations may be made f.o.b. New York City. Cash will be paid. Correspondence should be in French. In writing the Bureau, refer to opportunity 27,462.

N. A. S. E. Holds Annual Convention

PATRIOTIC ADDRESSES AND LECTURES ON FUEL CONSERVATION TOPICS
MAIN FEATURES OF CONVENTION AT CINCINNATI, SEPT. 9 TO 14

WHILE the attendance at the Thirty-Sixth Annual Convention of the National Association of Stationary Engineers was not so great as it has been in recent years, due undoubtedly to the extra work caused by so many engineers having gone into war service of the country, the features of the convention showed an improvement in that more time was spent on educational work in listening to lectures having to do directly with the operation of power plants and in live discussions following the presentation of these papers.

Meetings were held in Music Hall and the Mechanical Exposition of the National Exhibitors' Association was on display in the same building. The convention committee was fortunate in securing a number of speakers prominent in national affairs, and below are given abstracts of papers which dealt with technical subjects.

Roderick Mackay, of Los Angeles, Cal., was elected president for the coming year; John P. Callahan, Jersey City, vice-president; F. W. Raven, Chicago, secretary; and S. B. Force, Pittsburgh, treasurer. Next year the convention will be held at Huntington, W. Va.

Officers chosen by the National Exhibitors' Association for the coming year are: C. Cullen, of the Powell Valve Co., president; H. A. Smith, Philadelphia Grease Co., vice-president; F. N. Chapman, Leschen & Sons Rope Co., treasurer. Executive committee, L. W. Brooks, Jos. Dixon Crucible Co.; Frank Martin, Jenkins Bros.; H. B. Rogers, Bowers Rubber Co.; Hudson Dickerman, Johns Pratt Co.; Horace Rand, Chapman Valve Co.

FUEL REGULATIONS

TAKING this as the title of his message to the engineers, Pierpont B. Noyes, Director of Conservation of the United States Fuel Administration, said in part:

It is upon co-oporation rather than regulation that the Fuel Administration relies for successfully meeting the fearfully mounting demands for fuel made by the war. Production is increasing more than a million tons a week as compared with last year. This increase is limited by other equally urgent demands on man power and transportation, while the war's demand for more coal seems to have no limit.

Figures carefully compiled show that this country needs this year for war work plus such non-war requirements as cannot be safely neglected, 100 million tons more coal than was used in 1917—and the 1917 production was 50 million tons larger than this country ever mined before.

Such an increase cannot be made with the man power and transportation available. Yet, the war must have the coal. The answer lies in the work of three organizations built up by Dr. Garfield which together promise a solution of the threatened coal shortage: To increase production, stimulate conservation and systematize distribution is the task of these fuel organizations.

The final result will lie with the people of the country. The task is too huge for any man or organization unless he can obtain 100 per cent cooperation of every citizen. All the regulations issued by the Fuel Administration have been directed towards one of these three objects.

Dr. Garfield took up increased production first and has always made it his own especial work. He early established a relation with labor which has resulted in less interruptions from labor disputes than ever before in the history of the coal industry.

Rocking-chair critics are prone to cover this whole subject of production and annihilate the Fuel Administration by the statement "There are three trillion tons of coal in the ground." There are now more than three trillion tons of ice at the north pole. The available supply of both coal and ice is limited by man power and transportation.

The effect of war on these two necessary factors of coal production is suggested by the experience of European countries. In every belligerent country the annual coal production has seriously decreased since the war began save only in the United States. We increased 50 million tons in our first year of war and this year will add another 50 million to that. In almost any other line of activity the enterprise and energy of America is rightly counted on to make good, regardless of difficulties. Coal alone is of bulk too huge to be increased by any large percentage quickly. It must be remembered that 52 per cent of all railway cars are loaded with coal. A tonnage of coal equal to the entire cotton crop of the United States is moved every 1⅓ days —every eight days we are mining and transporting as great a weight of coal as the entire wheat crop of the United States. The coal we will mine this year is equal in bulk to 2¼ times the material removed in digging the Panama Canal.

An editor writer, one of the most censorious towards the Fuel Administration, reveals the common misconception of the part played by merely size in limiting any sudden increase of coal mining. This writer states "There can be no shortage of cars, because 5000 new coal cars have been put into service this year." Five thousand cars if running continuously without mishap would carry about 3½ million tons of coal—one-half of one per cent of the total coal mined.

With man power reduced by war demands, and transportation taxed to its limit by every war making department, the fair minded citizen will agree that 100 million tons increase of annual production after two years of war is a creditable performance for even American energy and efficiency and we must look to other means to fill up the gap between supply and demand.

The conservation bureau at Washington has organized power, light and fuel campaigns going into every industry in the United States, and in addition, an intensive campaign amongst domestic consumers; the figures now coming in showing results of all these campaigns are very encouraging. A quota has been set of 35 million tons to be saved in the boiler and power houses of industry, and 15 million tons in the home. If this can be accomplished, the gap between increased production and the much greater increase of demand, will measur-

ably be filled. The result is quite largely in the hands of the men represented at the convention.

That very difficult subject of industrial limitations is one that the speaker has been especially engaged in for many months, but lately, the War Industries Board has taken the lead in conserving through limitation, material and men needed for war activities. In general, the Government started with the idea that granting the war must be supplied with fuel, raw materials, transportation and men, the economic and industrial health of the country must be given consideration. During these months, wherein limitation of non-war output has been held somewhat in abeyance, warning has been continually issued to such industries that a transfer of their facilities to Government work should proceed as fast as possible.

The time has now come when limitation must be more drastic. Hundreds of thousands of lives are hanging on our ability to complete the war program of supplies. Private interests and economic considerations must give way wherever materials or men are short.

Industry must adapt itself to this situation. Farseeing men who have given ear to the warnings of the Government are already well along in the process of adapting their facilities and organization to a war basis. Some hardship is inevitable.

The Priorities Committee of the War Industries Board is meeting the War Service Committee of every industry at hearings wherein every aspect of the industry is presented. Limitations will be based on facts presented by these committees, taken in the light of the Government's necessities.

It is in connection with the distribution of fuel that the public runs up against regulation more than in any other department. Distribution is perhaps organized in the Fuel Administration more thoroughly than any other part of the work. Every week the distribution department lays on Dr. Garfield's desk a statement by districts, by states, and as a nation, showing the amount of coal produced during the previous week at all of the ten thousand or more mines. Also a statement of the amount consumed in every district taken from the postal card reports, and lastly, a statement of the amount of coal on hand, adding together the stock piles of every industry, and every dealer in the country. With this information, the streams of coal are directed to fit the needs of the different sections.

Perhaps the most drastic regulation is the zoning system which has been applied to the entire country. The coal mines are grouped into thirteen geographical districts, and the territory to be supplied by each zone is defined. This has stopped cross-hauls, i. e., coal hauled long distances, and often across two or three coal producing fields, just because a consumer prefers some particular kind of coal. The fuel output of the country being strictly limited by transportation and by cars, the cutting out of 800-mile trips for coal cars and substituting therefor 200- or 300-mile journeys obviously increased the coal output.

With the zone system in operation, it has also been possible to re-adjust sources of supply so as to furnish a larger market for those western mines which had not orders for all of their capacity, and thus relieving the overtaxed eastern mines, releasing their coal for necessary war work. This has resulted in what is called, "Zoning coal Eastward." Consumers west of the Mississippi who were getting coal from Illinois, or farther east can feel that they are performing a patriotic service in using, during the war, local coal, and releasing eastern coal for eastern consumption, and increasing the car supply. Exceptions to the zoning rules are provided for where a special kind of coal must be used out of its natural zone. This applies largely to byproduct, metallurgic and gas coals.

Another ruling which naturally created dissatisfaction was the reduction of anthracite and Pocahontas coal going to the west. This again was a war necessity. Moving bituminous coal to that portion of the country east of the Alleghany is one of the most serious problems of the war. The anthracite mines, being east of this so-called bottle-neck, every ton of anthracite, kept in that direction, is an extra ton of coal to the congested eastern region. Anthracite has been zoned so as to create the shortest rail journey. Pocahontas coal is needed to keep the steel works running, it is wanted by the navy, shipping board, and domestic consumers. The shortage of Pocahontas coal today means a shortage of steel, a shortage of the most necessary supply for the war. One of the most important regulations applies to the "byproduct coals." They are short, for steel making purposes, terribly short. Wherever byproduct is found in use for steam making or similar purposes it is diverted to the steel industries, other coal being supplied in its place. There will be heart burnings on the part of plant owners who lose their high grade coal, and get their power from coal containing fewer B. t. u., but here again, if the relation of this coal to the war were known to all, manufacturers would volunteer their byproduct coal to the Government, regulation or no regulations.

But it is not by regulation that the war is to be supplied with its quota of fuel. Nor is it by preaching patriotism. In my observation there is just as much patriotism in Cincinnati, or Chicago, in New England, or in the Far West, as there is in Washington. The co-operation we would surely get from all the citizens of the United States if all knew the facts as we know them would solve every problem, no matter how difficult. If you could hear all that I hear, sitting in the committees of the War Industries Board, as Dr. Garfield's representative, the extent of sacrifice would be safely left to yourselves.

There is tragedy in the fuel situation of today. This is a war of steel—and steel is short for lack of coal. Don't think in future years that the coal shortage brought no catastrophe because you never heard its crash. The tragedy threatening is a silent one.

Germany taught the world a new military science on March 21—that surplus of munitions will save human lives. Having collected a reserve of shells and guns and all the weapons of attack beyond anything the world has ever seen before, she pushed through a great offensive with a minimum of casualties. She proved that an offensive provided with shells to waste can save thousands of lives. The allied command has learned the lesson. Our great offensive which is to win the war, is planning a concentration of munitions that will make the German's concentration last spring look very small.

Every day come the orders for staggering quantities of munitions. It is not that we will fail to send over enough guns and ammunition so that everybody can shoot. That is the old idea of enough. The question during the next six months is, can we furnish General Pershing his ideal program. The answer is we cannot. We cannot produce enough steel to fill the General's orders. How nearly we come to it will depend upon the people back here in the United States.

Yet the great drive will be made—and it will succeed. The tragic picture in my mind is of General Pershing in February or March, or whenever the time has come next year, sitting down with pencil in hand figuring sorrowfully but sternly and with the matter-of-fact formulae of war, how many additional young men must be given to the slaughter to make up for this deficit in that ideal program of munitions which might have saved their lives. Military formulae will tell him, so many shells short, so many additional casualties. I have not overstated the situation. During the next few months it is surely coal against casualties.

If all these facts were known to everybody, do you think there would be need of preaching patriotism? Or need for rules and regulation? Very few in this great country would be found to place private interests or economic considerations in the balance against human lives.

David Moffat Myers, directly in charge of the Conservation Program Fuel Administration on the practical problems in connection with conservation in steam power plants, followed Mr. Noyes with a talk on fuel conservation. He stated that a total of 68 per cent of the total coal mined was used by the railroads and industrial plants, all of which were in charge of engineers, and as a consequence the conservation program depended largely on the hearty co-operation of the engineers. The present conservation measure, he stated, was not by any means perfect, but it was a war measure and it was better than no measure at all while waiting to perfect an ideal measure. The main point is to save coal, and the particular means taken to do it should not be too severely criticized.

It was not the purpose of the Fuel Administration to play any favorites, as many had openly asserted, in that it advocated the substitution of central station service in some cases in place of the private plant. It was simply a question of saving coal. An isolated plant using the greater proportion of its exhaust steam could use coal more efficiently at any time than the most ideal central station, but where the isolated plant wasted practically all the exhaust steam, it was possible in a great number of cases to generate current more efficiently by the central station.

Particular attention should be directed to educating the firemen, as a poor man with the best of equipment would be sure to defeat the efforts made in other directions. In every case, all that was asked was to use every possible means to maintain the highest efficiency with the equipment to be had, realizing that new equipment was practically out of the question in a great number of cases. They proposed to give everybody a square deal, that all the cards were on the table where all could see them and that all they wanted was the co-operation of all concerned. He further informed them that the office of the Fuel Administration at Washington was open at any time to anyone who wished to consult them and invited anyone of those assembled to bring their troubles to them and that if they had any complaints to bring them forward.

He drew attention to the necessity of having the settings absolutely tight, and the boiler clean inside and outside. Particular attention should be paid to the damper to see that it is open just enough to provide the proper amount of air and no more. Boilers should be so operated that the rate of combustion per square foot of grate surface would not be less than 20 to 25 lb. for bituminous coal and 10 to 15 lb. for anthracite coal. Records should be kept so that any variations in the performance could be detected at once and form a basis on which recommendations for improvements could be made.

The Fuel Administration, in his opinion, would be discontinued after the war, but the conservation program would continue in force in some form or other.

Some Modern Methods of Lighting Factories, Offices and Stores

G. H. Stickney of the Edison Lamp Co., Harrison, N. J., stated in his paper under the above title that the aim was to present some practical suggestions on the lighting of industrial plants, office buildings and stores. Different lighting methods, the various types of lighting units, types of the Mazda lamp and the advantages of the different types for various services and comparisons regarding the economy of these lamps as compared to the old carbon lamp were taken up in the first part of the paper.

This was followed by a discussion of the purpose of reflectors and the selection of fixtures. In general, the use of wide spacing permits the use of larger and more economical units and reduces the cost of wiring. Smaller units and closer spacings means an increased wiring cost but a greater elimination of shadows, and the failure of one unit does not put the whole section in darkness.

At the present time, he stated, steel reflectors are generally recognized as the standard industrial equipment. Porcelain enamel finish is most generally used. For the average condition experience has indicated that the dome type porcelain enamel steel reflector with bowl-frosted Mazda lamps is the most generally acceptable. Strength, durability and simplicity of maintenance are the essential requirements for fixtures for this service.

For rough work such as assembling, erecting, foundries and the like, a low intensity of from one to two foot-candles would be all that would be required. In machine shops working to close dimensions and work of similar requirements, four to eight foot-candles are necessary. The proper spacing of the lights for this service and flexibility of control by means of the proper arrangement of the circuits was also discussed.

For office lighting he stated the semi-indirect system was growing in favor. It is somewhat more efficient than the totally indirect and much better for the eye than the average direct lighting system.

The essential requirement for office lighting, it was pointed out, is that the employes can clearly see all work without the slightest eye strain. Glaring reflections and bright light sources must be eliminated

because they produce eye fatigue, headache and low bodily efficiency. For this reason general illumination has practically become the standard. The intensity recommended by the various authorities varies from three to five foot-candles with the average for ordinary work slightly over four foot-candles. For average conditions and direct lighting the lamps should be spaced a distance apart equal to the height of the ceiling. Indirect units can be spaced farther apart up to a maximum of one and one-quarter of the ceiling height, for ceilings up to 15 ft.

For the highest economy, direct lighting with prismatic glass bowl reflectors are recommended for stores. To provide a more attractive appearance or a brightly illuminated store, semi-indirect or totally indirect units are much preferable. The fixtures should preferably be of very simple designs.

The intensity will depend on the kind of goods handled as well as the effect of brilliant illumination as an advertisement—the better the illumination the more attractive the store as a whole will appear. The spacing of the lamps is usually governed by the size of the bay. From one to five outlets can be symmetrically arranged in a square bay. In office work it is a safe rule not to space the lamps much farther apart than the height of the ceiling.

The cost of lighting will, of course, depend directly on the price of power and the efficiency of utilization of light. Cost, however, cannot be considered alone, as it is just as important that the equipment be suitable for the work. In a table illustrating this point it was shown that the question of having light surroundings had a great effect on cost of operation as well as providing more satisfactory illumination. A table was also shown in which it was brought out that the co-efficient of reflection of various colors and materials varies from 4 to 82 per cent.

Finally, after the system is properly installed, it must be well maintained. Dust, grime and grease accumulate on reflector surfaces and lower their efficiency. Dirt also collects on the lamp bulb and prevents some of the light from coming out. After burning for long periods, lamps become coated on the interior surface of the bulb with small particles of the filament, in other words, blackened.

The exact amount of this loss of light will depend on local conditions. In an industrial town it will be far greater than in the open country. An inverted bowl will accumulate more dirt than a direct lighting reflector, and so on. To obtain maximum efficiency from the system the reflectors and lamps should be systematically and thoroughly cleaned at regular periods. Strict attention to this detail will in a great measure determine the operating cost as well as the satisfactory results from the system.

The Commercial Value of Exhaust Steam

This was the title of a paper by Frederick C. Ruck, chief engineer of the Public Museum, Milwaukee, Wis., who strongly emphasized the great economic advantage of utilizing in every manner possible the exhaust steam that now in most cases is going to waste. It not only would prove a great aid in the conservation of the fuel resources of the country but it also means a great financial gain to the owners of power plants and in many cases greater output with the same equipment and a better quality of product.

Attention was called to the fact that there is only a difference of 5 B. t. u. in the heat content of steam at 5-lb. pressure and that of steam at atmospheric pressure. For this reason it will be seen that there is practically no difference between the heating value of steam at the two different pressures, and the same temperature (if not better) can be maintained in a drying or heating apparatus with exhaust steam if a good circulation is provided.

In places where the product manufactured needs drying before or after being finished, or in places where there is a large amount of hot water used, such as in breweries, malt-houses, dye works, etc., where a temperature of 212 deg. or lower can be used, there is absolutely no excuse for using live steam at low pressure if there is plenty of exhaust steam available.

In cases where a large amount of boiling is done in open vats, steam at atmospheric pressure has not a sufficiently high temperature to do the work. In this case a live steam siphon can be constructed on the principle of the exhaust steam injector, using a small amount of live steam just enough to raise the temperature a few degrees above 212 deg. and in this manner a large saving can be made.

A series of tables compiled by the author was then shown, in which the commercial value of exhaust steam was estimated and also an interesting comparison of central station versus isolated plant power, lighting and heating service.

Generation of Heat from Bituminous Coal and Its Absorption by the Boiler

Henry Misostow read a paper under the above title in which he stated that, in order to obtain the best commercial combustion of bituminous coal, it is necessary to maintain a low distillation temperature, and means must be provided to obtain the proper mixture of combustibles and oxygen, and means must also be provided to insure a rapid preparation of combustible hydrocarbons for combustion.

In practical work the results depend on the load, furnace, chimney, coal and the man. With bad conditions and a good man, it is possible to obtain fairly good results, but a poor man will produce only indifferent results with the best of equipment. As a consequence, the man is the most important factor in heat generation.

The principal loss in combustion is by droppage of fuel through the grates and by incomplete combustion. These two losses can be easily detected, the first by coke in the ashpit and the second by dense smoke. Smoke of greater density than No. 2 indicates incomplete combustion to a wasteful degree.

The efficiency of heat transmission is determined by the ratio of heat transmitted to the total heat generated. There is also a further differentiation as to real efficiency and apparent efficiency. The total amount of heat indicated as absorbed, from gas analysis, is not all absorbed by the boiler. Part of it is used to raise the temperature of the air passing through the setting into the gas passages, and part is used to provide for radiation from the setting and the boiler. The best way to determine this is to determine the ratio between that indicated by

gas study and true efficiency, as determined by tests. Once this ratio is found, it may be used as a constant by which indicated efficiency from gas study may be multiplied in order to obtain a true boiler efficiency.

California Petroleum as a Fuel

This paper was prepared by a committee of California No. 2 of Los Angeles and read by Thomas J. Royer, and he began with a discussion of the beginning and growth of the petroleum industry and also the origin of petroleum. A table was also shown in which the yearly production for each year from 1875 up to the present time was tabulated.

The oil consumption for the year of 1917 in the state of California was 53,604,000 barrels. The railways used 23,470,000 barrels, steamships 6,600,000 barrels and the industries, including the public utilities, 23,472,000 barrels.

For the year of 1895 the price at the well was 80 cents per barrel, today $1.57.

Heating of the oil is one necessary requirement for atomizing the oil so as to obtain proper combustion. Atomization can be accomplished by either steam or air in a properly designed burner, air being somewhat less efficient, due to the loss in compression. Atomizing by high pressure through a small orifice is feasible, but it has the disadvantage that it is possible to maintain economically only a small fire with a single jet.

The types of burners most generally used are divided into two classes, one being known as the inside mixer and the other as an outside mixer. There is no particular advantage of either type and the difference is mostly in mechanical features.

An important feature of furnace construction is the checkerwork under the burners that control the admission of air, as this determines the uniformity of the heating and the completeness of the combustion.

The furnace should be constructed of such heat tested brick work that it will stand up under the high temperature developed, and the refractory material of which it is composed must be so installed as to radiate heat to assist the combustion of the heated ingredients of the fuel. The combustion must be complete before the gases touch the heating surfaces, or the flame may be extinguished, possibly to unite later in the flue connection or in the stack. For this reason ample space must be provided in the furnace. Finally there must be no localization of the heat on certain portions of the heating surfaces or trouble will result from overheating and blistering.

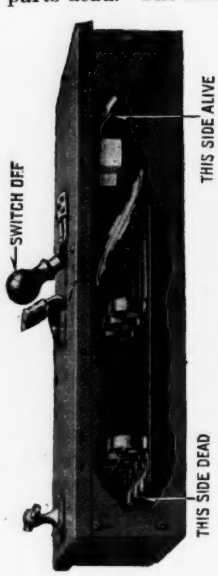
Regulation of the air supply is one of the most important points to be considered in the operation of oil fired boilers. Insufficient air causes a waste of fuel and an excess of air is just as wasteful. The proper procedure is to analyze the flue gases, but in case instruments are not available the air may be fairly accurately adjusted by watching the stack. For the most efficient operation a thin light gray smoke appears.

The Service Bureau of the Committee of Public Information, located at 15th and G Sts., Washington, D. C., will be glad to furnish any information in regard to officials, functions and location of all government departments.

The Krantz Safety Switch

In many steel mills, factories, mines and similar industries where most of the workmen have little knowledge of electricity, it is desirable to use switches having no live parts exposed or accessible in the ordinary operation of the switches or when replacing fuses.

This is fully accomplished in the Krantz Auto-Lock Switch, marketed by the Westinghouse Electric & Mfg. Co., which is intended for use on main circuits or wherever an ordinary knife switch is applied. The switching parts and fuses are enclosed in a steel box, the cover of which is in two parts, one being screwed on to form a permanent covering for that end of the box containing the switch, and the other part being hinged so as to swing back and permit the renewal of fuses, which are located in this portion of the box. An ingenious latching mechanism makes it impossible to open the cover without first throwing the switch to the "off" position and rendering all fuses and other accessible parts dead. The fuses may be replaced at any time with



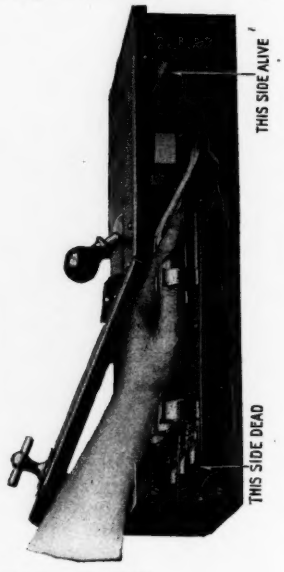


FIG. 1. KRANTZ AUTO-LOCK SWITCH

FIG. 2. WITH COVER UNLOCKED IT IS IMPOSSIBLE TO TOUCH LIVE PARTS

absolute safety. As long as the door of the case is open, the switch contacts cannot be closed.

By using a padlock, the switch handle can be locked in the "off" position, making it impossible for anyone to close the switch, except the person holding the key to the padlock. By using another padlock, the cover may be locked shut, so that the fuses cannot be tampered with. Either of these padlocks can be used independently of the other, so that the switch cover can be locked shut with the switch either "on" or "off," or the switch can be locked in the "off" position with the cover either locked or open.

Contact is made by means of a laminated spring copper brush, double ended with auxiliary arcing contacts at each end. The outer leaves of the brush are bronze to provide additional spring pressure.

The stationary contacts are of hand-drawn copper and are mounted on slate bases, one of which in the

fused switch carries one of the fuse clips while the other forms the terminal block for the incoming line and is mounted under the stationary portion of the cover.

The operating mechanism is galvanized steel of the toggle type, and is attached to the under side of the stationary end of the cover. This mechanism can easily be removed for inspection by removing several screws.

In closing, the pressure between the contacts causes the laminations of the brush to spread apart, giving it a wiping or self-cleaning action.

The double-ended brushes provide a double break, dividing the arc between the two ends, each of which is provided with a separate arcing tip.

In the closed position the switch is held in positive contact by throwing a toggle over center. A spring provides a quick-break for opening, the mechanism being independent of the operating handle.

These switches are supplied for 250, 500 and 600 v. for either alternating or direct-current service, and in capacities up to 2000 amp.

Positions Open

DIVISION OF ENGINEERING of the U. S. Employment Service, at 29 So. La Salle St., Chicago, lists the following positions as open for mechanical engineers:

385-2 Four electrical engineers for work in Ohio.

387-1 Five young mechanical engineers, graduates in a course in mechanical engineering, capable of taking position of assistant to the engineer in charge of levee building in Louisiana. (Civilian position with the army.)

377-2 One mechanical engineer to act as assistant on river and harbor work. Must be graduate in mechanical engineering and be familiar with testing boilers, machinery and furnaces. Location in Southern states. Salary $250 and subsistence.

For detailed information and registration blanks apply to Director of Engineering, 29 South La Salle Street, Chicago. The Division gives its services free of charge to all engineers, employers and technical men who register.

Correction Note

IN THE Practical Reference Tables published on pages 775 and 776 of the Sept. 15 issue appeared considerable data in regard to 85 per cent magnesia which were obtained from a pamphlet recently issued by the Magnesia Association of America. Credit was inadvertently omitted at the time of publication, and we learned since that the material is copyrighted but that some of the early editions of the bulletin from which we secured the data contained no copyright notice. Apology, however, is hereby extended to the association.

News Notes

THE COLLEGE OF ENGINEERING of the University of Illinois reports the following new appointments to its staff:

Department of General Engineering Drawing—Walter Elwood Farnham, Randolph P. Hoelscher, and James Earl Robertson, Instructors in General Engineering Drawing; Maurice Leon Cornelius, Half-Time Student Assistant in General Engineering Drawing.

Department of Mechanical Engineering — Edgar McNaughton, Associate in Mechanical Engineering; Earl D. Hay, Associate in Machine Design; Hussein Halouk Fikret, Instructor in Mechanical Engineering; Francis A. Hobart, Instructor in Machine Shop Practice and Management.

Engineering Experiment Station—Clemence William Hippard and Han Ho Huang, Research Graduate Assistants in Mining Engineering; Martha Isabella McQueen, Research Graduate Assistant in Ceramic Engineering; Samuel Russell Offutt, Research Graduate Assistant in Civil Engineering; William Louis Schwalbe, Research Graduate Assistant in Theoretical and Applied Mechanics; George Reed Shelton, Research Graduate Assistant in Ceramic Engineering.

U. S. CIVIL SERVICE COMMISSION announces an examination for mechanical engineer in experimental work, for men only. A vacancy in the Engineering Experiment Station, Naval Academy, Annapolis, Md., at $6.40 a day, and future vacancies requiring similar qualifications througout the United States, at this or higher or lower salaries, will be filled from this examination. Duties will be to conduct tests on mechanisms and other appliances constructed for use on vessels of the Navy, and to make adequate reports of such tests; and to prosecute research work that will be helpful to the designing division of the Bureau of Steam Engineering, Navy Department, Washington, D. C. Competitors will be rated on general education and technical training, professional experience and fitness, and publications or reports (to be filed with the application). Graduation with a bachelor's degree in mechanical or marine engineering from a college or university of recognized standing and at least 2 yr. subsequent experience with machinery and equipment are prerequisites. Applicants must have reached their twenty-third birthday on the date of the examination and all who are within the draft age must state in their applications their draft classification. Applicants must submit with their applications their photographs, taken within 2 yr., with their names written thereon. Apply for Form 2118, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

THE SARCO CO., INC., of New York, has opened a new office in Atlanta, Georgia, in the Healey Building, under the management of C. R. Dunwody, for the sale of Steam Traps and Temperature Regulators.

THE HEINE BOILER CO. on Aug. 30 elected C. R. D. Meier president of the company and James T. Brennan secretary and assistant treasurer.

B. H. TRIPP, special representative of the Chicago Pneumatic Tool Company on the Pacific Coast, has succeeded M. W. Priseler as District Manager of Sales for the Pacific Coast territory. His headquarters are at 627 Howard St., San Francisco. The Los Angeles branch of the company, at 521 Title Insurance Building, comes under Mr. Tripp's jurisdiction.

The Cincinnati branch office of the Lagonda Mfg. Co., Springfield, Ohio, has recently been moved from the First National Bank Bldg. to 2607 Union Central Bldg. Frank Walmsley, who has been handling the Lagonda business in Cincinnati for some time, is in charge.

Books and Catalogs

A DIRECTORY OF ENGINEERS, giving a brief synopsis of the experience and training of all members of the Association, issued for the good of the members and as an aid to the employer of engineers. Cloth, 6 by 9 in., 192 pp., $2.

This Directory of the American Association of Engineers improves upon the common society year book, and is an actual engineer's directory. It gives a brief synopsis of each member's experience and training, which will be of definite usefulness to the employer of engineers, who will be able to tell whether an applicant fills his needs without the loss of time from unnecessary interviews.

Classified tables have been compiled based on experience, so that it is possible to find a consulting engineer, an executive or a subordinate having specific experience and living in any definite locality. Thus if one needs a consulting hydraulic engineer, or a designer of machine parts, he is able to find men having this experience through the aid of the classified tables.

The 2204 members registered in the Directory are divided according to experience, as follows:

Members having Civil Engineering experience	71.9 per cent
Members having Mechanical Engineering experience	24.8 per cent
Members having Electrical Engineering experience	12.8 per cent
Members having Mining Engineering experience	2.3 per cent
Members having Chemical Engineering experience	2.9 per cent

The membership is divided as follows:

Consulting (Practical Engineers)	10.3 per cent
Contractors	1.2 per cent
Patent Attorneys	0.5 per cent
Executives (Officials, Managers, Superintendents, etc.)	40.4 per cent
Assistants, Draftsmen, etc	42.5 per cent
Students	5.1 per cent

Over 20 per cent of the members of A. A. E. are on the Association's Service Roll.

THE BUREAU OF MINES has just issued Bulletin 156, "The Diesel Engine, Its Fuels and Its Uses," by Herbert Haas, which is both informative and readable and contains the facts which the interested reader, both non-technical and technical, most desires to know. The characteristics of the type, theoretical, mechanical, and practical, concerning the engines built in this country, are given. The chapter on fuels desirable for these engines is especially valuable and timely.

Copies of this bulletin may be obtained free of charge by addressing the director of the Bureau of Mines, Washington, D. C.

CONDENSERS, Pumps, Cooling Towers, etc., is the name of Bulletin 112-A, recently published by the Wheeler Condenser & Engineering Co., Carteret, N. J.

Readers contemplating the installation of a condenser will be interested in a discussion in this bulletin entitled "Choice of Kind of Condenser" and in the remainder of the bulletin, which illustrates and describes other Wheeler condensing machinery in detail. The bulletin embraces large and small surface condensers, showing typical complete installations; rectangular and cylindrical types; jet condensers; barometric condensers; Wheeler Edwards air pumps; Wheeler rotative dry vacuum pumps; the Wheeler turbo air pump; centrifugal pumps for circulating water; natural and forced draft cooling towers. In addition, a page is devoted to the Wheeler feed-water heater and two pages to Wheeler multiple effect evaporators and dryers.

DETAILS OF CONSTRUCTION of the Detrick flat suspended arch are presented in a pamphlet from M. H. Detrick Co., Chicago. Illustrations show the arch applied to familiar makes of boilers and stokers.

BULLETIN NO. 1110, describing the Stratton air separator and covering the subject in greater detail than the company's previous bulletin, was lately issued by The Griscom-Russell Co., 90 West St., New York.

FRANCKE FLEXIBLE SHAFT COUPLINGS are described and illustrated in Bulletin No. 26, recently issued by Smith-Serrel Co., 90 West St., New York City. These couplings are designed to care for misalinements in shafts carrying loads from 500 hp. down and have the general outward appearance of an ordinary rigid coupling, the bolts of which, however, are replaced by flexible pins consisting of a bundle of flat steel springs held flexibly and radially in keepers.

SECTION 700A of General Electric Co. Bulletin 46,013, deals with instrument transformers, switchboard type. This is illustrated with halftone views of the different types of current and potential transformers, and contains curves and tables, the volt-amperes, watts, and power-factor given showing the amount required by the various devices used as secondary connected loads on current transformers, each of the values given in the tables representing tests made on one or several devices.

THE LAGONDA MFG. CO.'S Bulletin G-2 describes the Lagonda reseating machine for boiler cap and headers, containing full description of the company's electric, air, steam and water driven reseating machines. These machines are especially designed for use on boilers of the Babcock & Wilcox type, using ground joints between caps and cap seats in the headers. The Lagonda reseating machine is portable, and is used as shown in the illustrations. A copy of the bulletin will gladly be sent to anyone interested who addresses the company at Springfield, O.

ROSS HEATER & MFG. CO., INC., Buffalo, N. Y., has recently issued folders describing the Ross expansion joint in particular, and also the Ross heaters, condensers and other apparatus manufactured by the company.